LITTELL'S LIVING AGE.

Fifth Series, Volume XX. } No. 1741.—October 27, 1877. { From Beginning, Vol. CXXXV.

CONTENTS.

POETRY.

PUBLISHED EVERY SATURDAY BY
LITTELL & GAY, BOSTON.

TRANSLATIONS FROM HEINE.

BY THEODORE MARTIN.

"MEIN KIND, WIR WAREN KINDER."

My bairn, we aince were bairnies,
Wee gamesome bairnies twa;
We creepit into the hen-house,
An' jookit under the straw.

We craw'd like the cock-a-doodles —
An' to hear us the passing folk
At ilk "kickericoo" wad fancy,
It just was the bantam cock.

The kists in the yaird we papered,
And made them bonnie and crouse,
An' we dwalt there, we twa thegither —
The laird had nae brawer house!

. . . . . .

An' aften the neebor's auld baudrons
Look'd in for a mornin' ca',
We made her our bobs and curtsies,
And snoovelin' speeches an' a'.

"An' how hae ye been? an' how are ye?"
Was aye the o'erword when she came;
To mony a queer auld tabby
Sin' syne hae we said the same.

. . . . . .

Whiles, like auld carles we sat, too,
And oh! what gran' sense we talk'd then,
An' bemoan'd us, how things were a' better
In times when oursels were young men.

How love, an' leal hearts, an' devout anes
Had flown frae the warld clean awa';
How the price coffee stood at was awfu',
An' gowd no to come by ava'.

They are gane, thae ploys o' my childhood,
An' a' things are ganging, guid sooth!
The gowd, time itsel', and the warld,
Love, faith, and leal-hearted truth.

"UND WUSSTEN'S DIE BLUMEN, DIE KLEINEN."

If the little flowers knew how deep
Is the wound that is in my heart,
Their tears with mine they'd weep,
For a balm to ease its smart.

If the nightingales knew how ill
And worn with woe I be,
They would cheerily carol and trill,
And all to bring joy to me.

If they knew, every golden star,
The anguish that racks me here,
They would come from their heights afar
To speak to me words of cheer.

But none of them all can know;
One only can tell my pain,
And she has herself — oh woe! —
She has rent my heart in twain.

"SIE HABEN HEUT' ABEND GESELLSCHAFT."

They have company coming this evening,
And the house is ablaze with light;
Up yonder a figure in shadow
Sweeps past by the windows bright.

Thou seest me not, — in the darkness
I stand here, under thy room, —
Still less canst thou see the darkness
Is shrouding my heart in gloom.

My dark heart loves thee, adores thee,
It loves, and it breaks for thee, —
Breaks, quivers, wells out its dear life-blood, —
But all this thou dost not see!

"DIE JAHRE KOMMEN UND GEHEN."

Years come and go; generations
Are perishing day by day,
But the love that my heart aches with,
It never will pass away.

If once, but once, I might see thee,
And sink on my knees at thy feet,
And, dying there, dying might tell thee,
"I love thee, I love thee, sweet!"

Blackwood's Magazine.

LINES TO A TEACUP.

Dear little teacup,
Oh! my rare wee cup,
Work of Celestials! you must be divine;
Tea no one drank in
Porcelain of Nankin
So fit to rank in
Richer ceramic collections than mine.

Those curious blue marks,
Not sham, but true marks,
Prove you are nearly five centuries old;
In your young beauty
Perhaps you did brew tea
For the King Chuty,
Robed, like the sun, in a mantle of gold.

. . . . . .

Where is his charmer?
Who would dare harm her,
She who ruled over the ruler of men?
But in the places
Which knew her graces
She left no traces,
They have forgotten their fair denizen.

She was not brittle,
Frail perhaps a little,
Why is she missing, and you here to-day?
Say by what token
You are unbroken?
Patent to no ken
Is the distinction, for both are of clay.

From The Quarterly Review.

THE SCIENCE OF ELECTRICITY AS APPLIED IN PEACE AND WAR.*

NOT many years ago, a distinguished member of Parliament was asked to deliver a lecture to his constituents on the subject of electricity. It was necessary to obtain the sanction of the mayor for the use of the town hall. His worship's ideas of electricity were very limited; indeed, his knowledge of science generally resolved itself into a belief that scientific theories attacked revealed religion. It was impossible to disoblige the borough member, but the permission to use the town hall was accompanied by an intimation that although his worship, personally, did not entertain any objection to electricity, he earnestly hoped that the thing would not be carried too far.

Although we by no means consider electricity antagonistic to religion, we have a solid reason for not carrying the thing too far, which is, that we know too little about it. We know that it is present in the heavens above, and in the earth beneath, but in what the subtle element consists we know not. In most branches of physical science we can refer observed phenomena to some ultimate and universal elementary principle. But such is by no means the case with electricity; indeed, Sir William Snow Harris goes so far as to say, that almost every speculation relative to the phenomena of magnetism — and in this we must include electricity — partakes more or less of the nature of a mere hypothetical assumption. We have a large collection of observed facts, but with respect to the hidden or efficient cause of the facts, we really have no knowledge whatever. The problem that baffled Benjamin Franklin still defies Sir William Thomson; and the motive force still remains to be determined, of which Faraday said that he "once thought he knew something about it, but that the more he investigated it the less he found he understood it."

The telegraph has taken such a large place in the practical business of life, that the world in general is apt rather to look upon electricity only in light of an agent for rapid communication, than to regard it in its true position as one of the most extensively pervading elements of nature. It is true that the requirements of practical telegraphy have done, and may be expected to do, more than anything else, for the science of electricity and magnetism: accurate measurement of electrical quantities was a condition precedent of any solid improvement, and we owe it mainly to the demands of the telegraph operator that the requirement has been fulfilled. Men of abstract science were satisfied to know that the measurement and definition of electric resistance, electro-motive force, and so on, were within the range of scientific possibility; but the demand for such measurements and definitions was not sufficiently general to make it worth while to invent a compendious method of determining the one and stating the other. We owe to Gauss and Weber the first practical realization of a system of absolute measurement; but the principles laid down by them did not extend rapidly, even among the few by whom their theory was well understood, because there was no urgent need for its practical application.

The use of a definite electrical unit of measurement only became prevalent when it was imperatively required by the daily working of the telegraph. For many years measurements of electrical quantities were habitually performed in the telegraph factory and in the telegraph station-house, at a time when the means of performing them were still generally unknown in the scientific laboratories of Europe. The professors of science who threw out the general principle have gained a rich harvest from the seed they sowed: they gave the principle; they got back from the

* 1. *Papers on Electrostatics and Magnetism.* By Sir William Thomson, D.C.L., LL.D., F.R.S., F.R.S.E.

2. *Journal of the Society of Telegraph Engineers.* 5 vols.

3. *Handbook of Practical Telegraphy.* By R. S. Culley.

4. *Report from the Select Committee of the House of Commons on Post-Office Telegraph Department.* 1876.

5. *Magnetism.* By Sir W. Snow Harris, F.R.S. 1872.

6. *Der Elektromagnetische Telegraph.* Von Dr. H. Schellen, Director der Realschule Erster Ordnung in Cöln. 1870.

practical telegrapher accurate standards of measurement, and the ready means of transmitting those standards, and of preserving them for years without change; improvements of extreme value to the work of scientific research.

In a science so new and so progressive, the dogma of to-day will often prove to be the exploded fallacy of to-morrow; knowledge is so rapidly accumulated, and so many opposing views have at different times obtained assent, that those who have no special call to follow the progress of discovery hardly know, to use a homely phrase, where they are.

The philosophers of the sixteenth century, not having any definite notion of the phenomena of the compass needle, conceived it to be influenced by some mysterious point of force existing in the regions of space. Descartes and others supposed it to be under the dominion of vast magnetic rocks. Gilbert, taking a bolder view, conceived the terrestrial sphere to be in itself a vast magnet, endowed with permanent polarity, and hence approaching the general condition of an ordinary loadstone. The hypothesis of Halley on the subject will be gathered from the mention made of it in the speech of Sir William Thomson quoted below; and the theory remained pretty much where Halley left it till 1811, when the Royal Danish Academy proposed the variation of the needle as the subject for a prize essay, and so induced Professor Hanstein to undertake a re-examination of the whole subject; the result was, in his opinion, to establish the existence of four instead of two magnetic poles. These four poles Hanstein imagined to be of unequal force, and continually shifting their places. Each, he said, has a separate movement and period, and each has a regular oblique-circular motion round the poles of the earth. The stronger north pole he calculated to perform its cycle in 1740 years, the weaker in 1860 years: the stronger south pole in 4609 years, and the weaker in 1304 years. We mention this theory principally for the occasion it affords of transcribing, for the benefit of those who are curious in such matters, a note of Sir William Snow Harris on the remarkable coincidences involved in the numbers deduced by Halley from his researches.*

We pass over the learned investigations of the Rev. Mr. Grover, Professor Barlow, and M. Biot, all of whom are spoken of with respect by Sir William Snow Harris to come to the theory of Gauss. This accomplished philosopher, whose magnetic researches have become the admiration of Europe, starting from the general principle that magnetism is distributed throughout the mass of the earth in an unknown manner, succeeded in obtaining, partly by theory and partly by adaptation, a sort of empirical formula, which represents in a wonderful way the many complicated phenomena of the magnetic lines, and has thus embodied our knowledge of them in a law mathematically expressed: —

Gauss's investigation [we quote from Sir William Snow Harris] depends on the development of a peculiar function much employed in physical astronomy. . . . By this process it is demonstrated that, whatever be the law of magnetic distribution, the dip, horizontal direction, and intensity at any place on the earth may be computed. Having exhibited his resulting formula in converging series, Gauss determines the declination, inclination, and intensity of ninety-one places on the earth's surface, and which are found to coincide with observation: one great feature, therefore, in this theory of terrestrial magnetism is, that the earth does not contain a single definite magnet, but irregularly diffused

* "By a curious coincidence, these periods involve a number, 432, sacred with the Indians, Babylonians, Greeks, and Egyptians, as being dependent on great combinations of natural events: thus the periods 860, 1304, 1740, and 4609, become, by a slight modification, 864, 1296, 1728, 4320, which are not inadmissible, considering the complicated nature of the observations from which the first numbers are derived. Now these numbers are each equal to 432 multiplied by 2, 3, 4, and 10 successively. According to the Brahmin mythology, the world is divided into four periods: the first being 432,000 years; the second, 2 x 432,000; the third, 3 x 432,000 years; the fourth, 10 x 432,000 years. It is also, according to Hanstein, not unworthy of remark, that the sun's mean distance from the earth is 432 half-radii of the sun; the moon's mean distance 432 half-radii of the moon: but what is more especially striking is the circumstance, that the number 25,920 (= 432 x 60) is the smallest number divisible at once by all the four periods, and hence the shortest time in which the four poles can accomplish a cycle. Now this time coincides exactly with the period in which the precession of the equinoxes completes its cycle. Certainly curious and remarkable series of coincidences." — Sir Wm. Snow Harris's "Magnetism," p. 17.

magnetic elements, having collectively a distant resemblance to the condition of a common magnet.

It will be acknowledged that among all these authorities we want a sure guide to lead us by the hand; fortunately we are able to obtain such assistance. Sir William Thomson, the acknowledged chief of living followers of applied science, a short time ago, in delivering the annual president's address to the Society of Telegraph Engineers, took occasion to define the present state of our knowledge on the subject of what he called atmospheric electricity: * —

As to terrestrial magnetism, of what its relation may be to perceptible electric manifestations, we at present know nothing. You all know that the earth acts as a great magnet: Dr. Gilbert, of Colchester, made that clear nearly three hundred years ago; but how the earth acts as a great magnet, how it is a magnet, whether it is an electric magnet in virtue of currents revolving round under the upper surface, or whether it is a magnet like a mass of steel or loadstone, we do not know. This we do know, that it is a veritable magnet, and that there is a motion of the magnetic poles round the axis of figure, in a period of from nine hundred to a thousand years.

When the phenomena of terrestrial magnetism were first somewhat accurately observed, about three hundred years ago, the needle pointed here in England a little to the east of north. A few years later it pointed due north; then, until about the year 1820, it went to the west of north, and now it is coming back towards the north. . . . Everything goes on as if the earth had a magnetic pole revolving at a distance of about twenty degrees round the true north pole. . . . About two hundred years from now we may expect the magnetic pole to be between England and the north pole, and in England at that time the needle will point due north, and the dip will be greater than it has been for a thousand years, or will be again for another. That motion of the magnetic pole in a circle round the true north pole has already, within the period during which accurate measurements have been made, extended to somewhat more than a quarter of the whole revolution. It is one of the greatest mysteries of science, a mystery which I might almost say is to myself a subject of daily contemplation, what can be the cause of the magnetism of the interior of the earth. Rigid magnetization, like that of the steel or the loadstone, has no quality in itself, in virtue of which we can conceive it to migrate round the magnetized bar. Electric currents afford the more favored hypothesis; they are more mobile. If we can conceive electric currents at all, we may conceive them flitting about. But what sustains electric currents? People sometimes say, heedlessly or ignorantly, that thermo-electricity does it. But we have none of the elements of the problem of thermo-electricity in the state of underground temperature which could possibly explain, in accordance with any knowledge we have of thermo-electricity, how currents round the earth could by its means be sustained. And if there were currents round the earth, regulated by some cause so as to give them a definite direction at one time, we are as far as ever from explaining how the channel of these currents could experience that great revolutionary variation which we know it does experience. Thus we have merely a mystery. It is rash even to suggest an explanation. One explanation has been suggested by the great astronomer Halley; that there is nucleus in the interior of the earth, a magnet, not rigidly connected with the upper surface of the earth, but revolving round an axis differing from the axis of rotation of the outer crust, and exhibiting a gradual precessional motion, independent of the precessional motion or the outer rigid crust. I merely say that has been suggested. I do not ask you to judge of its probability: I would not ask myself to judge of its probability. I only say that no other explanation has been suggested.

* Journal of the Society of Telegraphic Engineers, No. vii. p. 5.

This is the latest word on the state of electric science. The ultimate cause is unknown, but two or three things, as appears from this extract, we may allow ourselves confidently to accept. The earth is a great magnet; but how magnetized we do not know. The magnetic poles revolve round the axis of the earth's rotation; but why, we do not know. The probability, as Sir William Thomson thinks, is that the magnetism of the earth is induced, a term we shall have to discuss further on, by atmospheric currents of electricity revolving round it; but why and how they so revolve Sir William evidently considers entirely unproved. He dismisses as untenable the theory of thermo-electricity, first, we be-

lieve, started by Sir David Brewster, who imagined * that the magnetism of our globe depended on thermo-electric currents, produced by the heated belt of the equatorial regions and the mass of the polar ices on either side of it. It is, however, plain that although Sir William Thomson dismisses the thermo-electrical theory as untenable, he considers the magnetism of the earth to be produced by electric currents, circulating around it in virtue of some cause to us as yet unknown.

It may be interesting to describe, in confirmation of this view, the ingenious experiments made by Professor Barlow. He wound a copper wire spirally around a hollow globe of wood in such a manner as to make the coils coincide with the parallels of latitude; he then covered the sphere and its spiral wire with the pictured gores of a common globe in such a way as to bring the poles of the electro-magnetical spiral into the same position as the observed terrestrial magnetic poles. The globe, thus arranged, was then placed under a delicately suspended needle, and electro-magnetic currents were caused to circulate through the spiral wire beneath the paper surface. It is a very remarkable fact that the needle so suspended represented on a small scale, under the influence of the spiral currents, all the phenomena of dip and variation exhibited by the compass-needle on the actual globe. Professor Barlow thinks "that he has proved the existence of a force competent to produce all the phenomena of terrestrial magnetism without the aid of any body commonly called magnetic." But we will not further weary our readers; they will probably be inclined, in the face of all these varying theories and ingenious experiments, to agree with Sir William Thomson and Sir William Snow Harris, that although we may reason of observed phenomena, the inducing causes of those phenomena remain a mystery of which we know nothing.

If anything can contradict the saying of Solomon that there is nothing new under the sun, it is the recent development of the powers of this mysterious agency. Neither the toying of Greek philosophers with amber, nor the description of the magnet by Lucretius, nor even the alleged knowledge of the mariner's compass by the ancient Chinese, detract from its novelty. The application of electric force to the practical affairs of life belongs to the last forty years. Our old men remember when it took many months to get a letter to India; but the rising generation would think themselves ill-treated if they did not read in the *Times* each morning the report of any important event which had occurred in India the day before. Electricity rings our bells, lights our shores, runs our errands, and, as we hope, will blow up our enemies if they approach our coasts. It has become indispensable in peace, and doubly indispensable in war. Last, not least, it has young and vigorous literature, and a special language of its own. It is perhaps owing to the latter circumstance that it is not more generally studied. Its text-books bristle with technical terms completely strange to the uninitiated, and even those terms have not in all cases arrived at their final and definite meaning. Besides this, mathematics have stepped in and claimed it for their own.

> The hard-grained Muses of the cube and square,

as Tennyson calls them, have more and more taken possession of it.

The reasoning of writers on magnetic subjects is now so uniformly conveyed by means of algebraic symbols, that only a skilled mathematician can follow them with comfort. This is doubtless unavoidable in the case of masters dealing with the higher branches of a science that depends on highly abstract reasoning; we do not complain, we only assign the fact, as one cause of the purely esoteric position that electricity is rapidly assuming. We are quite ready to admit the truth of Miss Moucher's remark, that there is a rule of secrets in all trades; the physician's prescription is still written in Latin, and Miss Cornelia Blimber gives her analysis of Little Dombey's character in numbers. We all know how that delightful lady, taking eight as her standard or highest number, found the poor child's natural capacity stated at six and three-fourths: violence, two; and inclination to low company, as evinced in the case of a person named Glubb, originally seven, but since reduced: but notwithstanding these precedents, outsiders like ourselves may be permitted to speculate whether a good deal of information might not be made public property which is now hidden under a heap of symbols.

Whatever we may think of the propriety of always affecting mathematical notation, we have no intention of laughing at the very ingenious nomenclature which

* Sir William Snow Harris quotes as his authority for Sir D. Brewster's views, "Edin. Phil. Trans.," vol. ix.

has been adopted by the framers of electrical language. It must be confessed that it sounds strange to unaccustomed ears; but we must remember that it was invented to express ideas absolutely new, and that the mind soon becomes used to any word to which definite signification is attached. When electricity passed from the position of a phenomenon to be studied only by philosophers, into that of an agent subservient to the daily wants of man, it was found necessary to invent words and technical terms to express its new conditions. No doubt it is possible, as we propose to show, to express the main facts and even the scientific methods of electricity without employing symbols, or unduly parading its scientific terminology; just as a traveller, returning from a distant country, can gossip pleasantly about the wonders he has seen, describe the manners and customs of the people, and even give a very fair idea of their cultivation and modes of thought, without conveying his information in a foreign language.

Still, as we cannot quite keep clear of technicalities, we propose to do the next best thing; namely, to collect them in a couple of preliminary pages, which well-informed people, and very idle people, are hereby solemnly warned to skip.

It is not of course to be supposed that the "Journal of the Society of Telegraphic Engineers," and the writings of Sir William Thomson on "Electrostatics and Magnetism," the titles of which are at the head of this article, will afford the inquirer much information of an elementary character. Written by professed masters of the science and addressed to a professional audience, these works presuppose a kind of information which the generality of people are not likely to possess. But if we succeed, as we hope to do, in giving such a general outline as will supply this defect, our readers will find in the "Journal" a mine of interesting information. The society from which it emanates is only in the seventh year of its existence; but it has already assumed a leading position among learned societies, and it numbers among its members most of those who, either in this country or on the Continent, have devoted themselves to electrical science. The papers it contains, written and read from time to time by busy men on subjects arising in the daily exercise of their calling, are of course desultory, but it will be found that few improvements worthy of remark have escaped notice; and the progress of telegraph work all over the world has provided a body of skilled and able observers, whose collective watchfulness will no doubt soon raise the new science from the somewhat empirical position it has hitherto occupied, and enable it to rank with the more exact branches of physical research. The daily experience of telegraphic operators, constantly noting new electrical phenomena, and with busy brains puzzling out their cause, ranges of course far beyond the comparatively narrow domain of mere telegraphy, and the labors of the leading telegraphists have gone far to build up a tenable theory of electricity; but, as we have seen, their acknowledged leader, Sir William Thomson, is fain to confess that the desired object is not yet by any means attained. Sir William's own papers on "Electrostatics and Magnetism" are marvels of industry and patient research. But it must be confessed that they are "caviare to the general." The titles of them alone would be enough for most people. For instance, one that we transcribe almost at random from his table of contents, on "Hydrokinetic Analogy for the Magnetic Influence of an Ideal Extreme Diamagnetic," sounds anything but light reading. Fortunately we are not obliged to invade this part of the learned professor's domain; we consult him principally for his opinions on the general magnetic condition of the earth, and for occasional dicta on subjects which he is acknowledged to have made especially his own.

It is hardly necessary to remark that to voltaic or current electricity, and to its congener electro-magnetism, all modern improvements are due. Frictional electricity, such as was known to Franklin, and to observers before the time of Galvani, though it is a manifestation of the same force which now works our telegraphs and explodes our torpedoes, so far differs from it in kind that it could never have been utilized in the every-day business of life. In modern electrical parlance, frictional electricity was high in tension and deficient in quantity; it could break with ease through the opposition of a non-conductor which would stop the feebler current of an ordinary galvanic battery, but its energy was exhausted by the effort of a single discharge. There was a spark; a crack; a shock if any sentient being was in the circuit — and then all was at rest. There was no means of obtaining a continuous current such as that we now command at will. A modern battery combines both requirements, it will keep up a continuous stream of electricity through a long circuit, for days and even

for months together. It can, on the other hand, be so arranged as to deliver a flash, of power so tremendous that it would penetrate thick glass, or leap from pole to pole of conductors held a yard apart. It is this manageable nature of the agent which gives it all its value.

The discovery of current electricity was the result of pure accident. The wife of the professor of anatomy at Bologna being indisposed, her physician prescribed a broth of frogs. It would seem that the professor's domestic and professorial arrangements were carried on in the same apartment, for the frogs destined for the lady's refreshment were laid out, properly prepared for cooking, on the table where the professor was engaged with his electrical machine. With true scientific curiosity, Galvani tried a few experiments with the animals before they were consigned to the pot. A spark from the conductor caused their limbs to contract: struck by a phenomenon new to his experience, he determined to follow it up, and devoted himself to experiments on the electricity of animals with such zeal, that he became the terror of every pond near Bologna. He one day hung a dead frog by a copper hook to the iron balcony of his window. The limbs of the animal became convulsed, and the professor, unable to account for the phenomenon, took refuge in the hypothesis of what he called animal electricity, supposing opposite kinds of electricity to exist in the muscles and nerves.

This theory Galvani supported till his death with great ingenuity and determination; but a rival philosopher, Volta, professor of physics at Pavia, started a new view. He contended that the two metals, copper and iron, in the experiment of Galvani, were the real electromotors, and that the muscles of the dead frog only played the part of moist conductors in completing the circuit.

This was vigorously opposed by the partisans of Galvani, and a scientific war of opinion waged for many years between the schools of Bologna and Pavia, out of which Volta ultimately came victorious. Volta, in the course of a series of experiments, in which he tried to produce effects similar to those witnessed by Galvani, substituted other substances for the animal tissues, which Galvani regarded as essential, and discovered the means of producing a continuous current, which is called after him, voltaic electricity. Although Volta was right in his main contention, he had only advanced one step beyond Galvani, when he, too, fell into error. It was his opinion that the simple contact of two dissimilar metals was sufficient to produce an electric current; but the theory now generally adopted is that first suggested by Fabroni, which regards chemical decomposition as necessary to the development of the voltaic current. The contact theory of Volta assumes that the origin of the action is due to the simple contact of two dissimilar metals, and that the mere juxtaposition of these begets and sustains a force which is the sole cause of all the energy displayed. But Volta, and all those who afterwards supported him in his view, were ignorant of dynamics. They did not know that the quantity of energy in the universe is constant, that to create *de novo* the smallest fraction of it is as far beyond the power of man as it would be to add one grain of matter to that which is already in existence. All that man can do is to alter the direction of existing energy, but in whatever form it is made to appear it is but the equivalent of some pre-existent form, which, Proteus-like, is driven to assume an altered shape. It is now thoroughly understood that in a zinc-copper battery the decomposition of the zinc is a condition necessarily precedent to the production of a current.

It has been customary to speak of electricity as if it had a distinct existence, and were an extremely subtle fluid capable of flowing as a current. The theory of Symner, as this hypothesis is called, however convenient for the purpose of simplifying explanation, must not be looked upon as scientifically tenable. Symner assumes that every substance in nature contains an indefinite quantity of an imponderable matter formed by the union of the two fluids, to which the names of positive and negative electricity have been given. These two fluids when in combination neutralize each other, and the body containing them is then said to be in the neutral or natural state. By friction, and by several other means, the two fluids may be separated; but one of them cannot be produced without the simultaneous production of the other. Such is the theory; but, however convenient it may be for the purpose of reasoning about a purely abstract idea in the common language of life, it contains fundamental errors. There is no fluid, properly so called; the agency exists only as a force. Its subdivision, then, into mutually opposing fluids also falls to the ground. Sir William Thomson says that, although according to pre-

vious writers, "a hypothesis of two magnetic fluids has been adopted, no physical evidence can be adduced in favor of such a hypothesis, but, on the contrary, recent discoveries, especially in electro-magnetism, render it extremely improbable."*

The term "electric fluid" must be looked on as purely conventional; electricity must be conceived of as a force, pervading all nature, latent in every substance, and liable at any moment to be excited by mechanical or chemical means. This force obeys certain laws, and acts in a particular manner; but the terms "fluid" and "current" do not accurately represent its action, inasmuch as it does not flow bodily from place to place, as a current would do, but follows rather the analogy of the undulations of light or the waves of sound. This, however, is of little practical importance; it is enough for our present purpose that the earth is an inexhaustible reservoir of electricity, and that it is possible to separate a portion of that electricity from the main body. The portion so separated will struggle to escape and recombine, and the energy it thus exerts can be utilized for the purposes of work. In forcing its way through or over obstacles, electricity exerts force which may be directed, utilized, and measured.

Force may be exerted either to produce motion in bodies at rest, or to oppose resistance to the motion of moving bodies. In either case it will do a definite amount of work, and that amount of work can be compared with a standard. The first step, then, was to contrive a standard, by which electrical energy might be measured, and in terms of which it could be expressed. In mechanics, a force sufficient to raise one pound to the height of one foot, affords such a standard, for it is practically invariable. This would be too rough for the measurement of electrical force, which is minute in quantity; but one analogous in conception has been adopted: namely, a force which will lift one gramme to the height of one metre, in one second of time; this standard force has been named an "absolute unit." In measuring a force it is not necessary to inquire whether it is employed in promoting motion or in resisting it; so that the strength of a current, the resistance offered by a wire to the passage of a current, the quantity of electricity passing through a given circuit, and the capacity for electrification of a given condenser, can all be expressed in the terms of the absolute unit.

* Electrostatics and Magnetism, p. 340.

The next step was to invent and give a name to some measure which should be an accurate multiple of the absolute unit. A man calling for a pint of wine does not calculate the cubic contents of his bottle; he compares the quantity he buys with a standard pint: and if he buys a cask, he ascertains that it contains a certain number of standard quarts. In the same way electricians have given to their standard measure, and to its derivatives, names which sound very strange to unaccustomed ears, though they fulfil very well the objects for which they were designed, being short, striking in sound, easy to remember, and significant.

The whole of this useful labor was performed by a committee of the British Association, which was appointed some years ago, and comprised most of the principal electricians of the country; their report has been adopted both in England and abroad. They found that a prism of pure mercury, one square millimetre in section, and 1·0486 metre in length, at a temperature of 0° centigrade, offered a resistance to the passage of a current equal to ten millions of absolute electric magnetic units. This measure they called a "British Association unit," or shortly a "B. A." unit. This designation has now been practically superseded by an arbitrary name; it is called, after a great electrician, an "Ohm." Certified copies of this standard, consisting of coils of platinum silver-wire, each of which oppose to an electric current a resistance equal to a given number of ohms, are now everywhere obtainable. They are known by the name of resistance-coils, and are marked with the number of ohms' resistance which they offer. They are conveniently arranged in boxes, and so connected that a current can be easily passed through any required resistance; and at the present time all electrical resistances are as habitually measured in ohms, as liquids are by the pint, or ribbons by the yard.

Force being imponderable, we can measure and weigh only the work which it performs; the names of weights and measures employed in electrical science are coined out of the patronymics of those who have been distinguished in electrical science. Faraday gives his name to the unit of capacity, under the name of a "Farad;" Volta impresses his name on the unit of tension, under the name of a "Volt." The unit of current is called of the professor of that name, a "Veber." The unit of resistance, as we have said, is an ohm. These designations are

further compounded with Greek adjectives, a "macrofarad" is a million times, and a "microfarad" the thousandth part of, a farad. A "megohm" is a million ohms, a "megaveber" a million vebers, and so on.

We need, however, trouble ourselves very little with the greater part of these names; the reader who will take the trouble to remember that the ohm is the standard measure of electricity, and who will glance at the explanation of some half-dozen electrical terms which we now proceed to describe, may consider himself free of the guild as far as the purposes of this paper are concerned.

The first, and perhaps the most important of these terms is the word "potential:" to say the truth, the text-books are curiously puzzling in their attempts to explain it. The matter is, however, very simple. If two electric batteries, or other sources of electricity, A and B, are of different electrical strength, there will be a tendency in the electricity at the point most highly electrified, to combine with that at the point of lowest electrification.

If A were electrified twenty times as strongly as B, the potential of A would be said to bear to the potential of B the proportion of twenty to one, and the greater the difference of potential the more strenuous becomes the effort of the electricity to recombine. It would force its way at once from one point to the other, were it not that air is a non-conductor, and electricity requires a prepared path or conductor to travel over. If the two points be brought close together, before they actually touch, a spark will overcome the resistance of the intervening air, and spring from one to the other; but if, instead of approaching the two points to each other, the distance between them is bridged over by a conductor, the same thing will occur; the only difference will be that, supposing the electromotive force to be constant, in the first case there will be a succession of sparks, and in the second a continuous current. It matters not whether the distance to be overcome be traversed by the leap of a spark across half an inch of air, or by the passage of a current along a thousand miles of telegraph; the cause is in each instance the same, namely, difference of potential between the two poles. This is an axiom of fundamental importance. The anxiety of electricity to recombine is called its "tension," and the degree of tension existing on any substance is spoken of as the potential of that substance.

Very often by atmospheric agency, or by some other of the many means which nature employs in such cases, a difference occurs in the electrical potential of the earth at two places on its surface, say at New York and in London, and the result is an earth-current passing from one to the other, very much, as we shall presently see, to the embarrassment of telegraph-working between those two localities.

Our next definition must be the meaning of electrical *resistance*. Every substance can be electrified; some very easily, and some with great difficulty. For instance, the metals, with German silver and copper at their head, can be electrified almost instantaneously. Other substances, such as glass, carbon, shellac, or gutta-percha, take a very long time, and very strong and persistent electric excitation to become so. Those substances which are quickly electrified are roughly, but not very accurately known as conductors; and those over which electricity moves slowly, are with equal inaccuracy, called insulators. It is all a question of degree; the best conductor offers a certain amount of retardation, or, in electrical language, resistance, to the march of the fluid; and the worst conductor known is permeable in time, and does not afford perfect insulation. To be sure, electricity moves along a copper wire at the rate of two hundred and eighty-eight thousand miles a second,* and it would take a very long time to creep over a few inches of gutta-percha; but as a mathematical fact, neither insulators nor conductors are perfect. If we take one hundred as the standard of conductivity, or absolute non-resistance, pure copper wire would show, perhaps, ·95 or ·96 of conductivity, and consequently ·05 or ·04 (the reciprocals of those numbers) of resistance. Gutta-percha, at the other end of the scale, would perhaps show ·01, or perhaps not nearly so much, of conductivity, and ·99 of resistance. A mathematical formula, discovered by Ohm, states electrical resistance to be inversely proportional to the strength of the current.† We see the result of this in the case of a lightning conductor. A small copper wire would carry away a moderate current without disturbance; the current and the resistance of the wire would have some man-

* See page 204.

† $I = \frac{E}{R}$ where I is the intensity of the current, E the electromotive force, and R the resistance.

ageable relation to each other; but a flash of lightning discharged along the same wire would be so intense that it would fuse the wire. The resistance would be the same, but the proportion would be destroyed by enormously multiplying the strength of the current.

On the same principle, a piece of carbon introduced into a circuit would stop the passage of a feeble current, being a bad conductor; it would, however, let a stronger current pass, but before doing so it would offer such a vigorous resistance, that the energy necessary to overcome it would develop caloric sufficient to heat the carbon white hot. This is the principle of the electric light. The reader will now, we hope, follow us when we speak of the resistance of a wire, a battery, or an electric circuit of any kind.

We now come to electrical *induction*. This curious property of electricity exercises a most important and sometimes a very unmanageable influence, in practical work. Indeed, it would hardly be too much to say that it thrusts itself into every problem which arises for solution. Sometimes it is utilized to the greatest advantage, as when it is applied to the purpose of storing up electricity ready for future service in condensers or accumulators; sometimes, as in the case of the well-known Ruhmkorff coil, it is invaluable in producing secondary currents even more useful than the direct products of the battery. Sometimes it presents itself in a less manageable form, as an influence retarding, and nearly destroying, the transmitted currents in submarine cables; but in whatever form it appears, whether as ally or as opponent, it plays a most important part.

Electrical induction may be defined as the mutual effect of electrified conductors in presence of each other, but separated by a non-conductor. The phenomenon may be produced in its simplest form by fixing two pieces of tinfoil, facing each other, one on each side of a sheet of glass. If the tinfoil on one side of the glass be connected with the earth by a wire, and the tinfoil of the other side be connected with a battery or electrical machine, electricity will be simultaneously produced on both sides of the glass, and the two electricities so produced will hold each other prisoners by their mutual attraction through the glass, till one or other of them is discharged, or till they are allowed to unite by means of a conductor. This "holding" power is utilized in the shape of instruments known as "condensers," for the purpose of storing electricity. A large number of sheets of conducting material, such as tinfoil, each separated from its neighbor by a non-conductor, for instance, paraffined paper or sheets of mica, are bound up together; when in use one of each pair of conductors is connected with earth, and the other with a battery; a number of such pairs, packed in convenient form, and connected together in series, may store up any required amount of electricity for the purposes of experiment or work.* Condensers are now sold with their capacity in farads marked upon them.

Like most of the discoveries which have made the progressive development of electrical science possible, the invention of the Leyden jar, as the earliest and best known form of condenser is called, was the result of a lucky accident. It dates from the last century. Most amusing accounts are given of the dismay with which the discoverer looked upon its effects. Professor Muschenbroek, it seems, had been thwarted in some of his experiments by the escape of electricity into the air. This he attributed to the vapors and effluvia suspended therein. It occurred to him that if he could electrify water in a glass bottle, the dissipation of the mysterious fluid might possibly be prevented. He accordingly half-filled a bottle with water, and proceeded to electrify it from a battery. When he considered the water sufficiently charged for his purpose, he attempted to remove the connecting wire with his left hand, holding the bottle in his right. He received a shock which terrified him beyond measure. He wrote to his friend Réaumur that he had received a blow on his arms, shoulders, and breast; that he lost his breath, and was two days before he recovered from the shock and the terror. In Muschenbroek's experiment the water acted as the inner coating, the glass, as usual, was the dielectric, the professor's right hand, as he held the bottle, was the outside coating, and the left, when he innocently touched the wire, completed the circuit, and discharged the stored-up fluid through his body. Modern Leyden jars are glass vessels coated inside and out with tinfoil. Muschenbroek wrote to his friend Réaumur that for all the kingdom of France he would not receive another shock; but he was sufficiently public-spirited to try the experiment on his friends; they were almost as alarmed as

* The electricities will be of opposite name, that is, if the battery current be positive the induced current will be negative, and *vice versa*.

himself. M. Lallamand, on taking a shock, declared that he lost the use of his breath for some ten minutes, and then felt so intense a pain along his right arm that he feared permanent injury to it. Herr Winkler stated that the first time he underwent the experiment he suffered great convulsions through his body; that it put his blood into agitation; that he feared an ardent fever, and was obliged to have recourse to cooling medicine. This professor was a very bold man. He administered a shock to his wife, and it made her nose bleed. From all which we learn that either the electrical machine, or the imagination, of Professor Muschenbroek, possessed a strength unattainable in these degenerate days.

A curious, and to practical telegraphers a very convenient, development of the phenomenon of induction is offered in the case of submarine cables, by the retardation of signals. A telegraph cable is, as one may easily see, only an elongated condenser; the copper wire of which, representing the inner coating, is separated from the outer coating of water and earth in which it is laid by its gutta-percha insulator. It is obvious that two or three thousand miles of wire present collectively an enormous inductive surface; indeed, Sir W. Thomson tells us that, if it were possible from some extraneous source to give a charge of electricity to the whole earth, no greater amount would be necessary for that purpose than is held prisoner by a few miles of cable.* The holding power of the wire when fully charged is very great; so great that a current, instead of flowing through the cable with the rapidity of light, follows one may almost say, the analogy of a viscous fluid, and dribbles through with comparative slowness.

On submarine telegraph cables messages are transmitted at the rate of fifteen or twenty words a minute, whereas, if the effect of induction could be removed, three or four hundred words per minute might be sent. The current has been experimentally found to move through the Atlantic cables at the rate of 6,125 miles per second — an enormous velocity, of course, but nothing like the pace of the fluid in overhead insulated wires. The speed of electricity under the latter circumstances was found by Sir Charles Wheatstone to equal two hundred and eighty-eight thousand miles per second. This enormous speed, forty-five or forty-six times as great as the velocity of the current through a submarine cable, was ascertained in a manner which has since become the standard method of measuring enormous velocities and infinitesimal fractions of time. Wheatstone suspended around the walls of his lecture-room at King's College about four miles of wire. On his table he placed a little instrument which he called a spark-board, and before the spark-board he made a circular mirror rotate at the rate of eight hundred turns per second. The wire was so arranged, that its two ends were connected one with the outer and one with the inner covering of a charged Leyden jar. When the jar was discharged, the spark traversed the whole length of the wire. But in the wire were three beaks. The first occurred at the spark-board, soon after the wire left the jar, the second at the end of two miles of wire, and a third just before the wire returned to the jar. All these openings were so arranged as to occur at the spark-board. The current of the jar at the moment of discharge was thus made to show itself in the form of a spark three times, as it overleapt the three intervals; these were reflected in the mirror. When the mirror was at rest, the sparks showed only as three dots; but when the mirror was made to revolve very rapidly, the dots changed into lines of light, the length of which varied with the rapidity of the revolution of the mirror. By measuring the length of these lines and the rate of rotation of the mirror, and noting how much the central line lagged behind the others, Wheatstone was able to calculate how long the spark took to traverse the intervening wires. This experiment gave, as we said above, two hundred and eighty-eight thousand miles per second for the velocity of the spark.

One of the exemplifications of induction most familiar to our senses, is a thunderstorm. Here, again, the analogy of the Leyden jar comes into play; the earth, highly charged with electricity, is separated by a non-conducting stratum of air from the thunder-cloud, also charged to a high potential. The two electricities, that in the earth and that in the cloud, hold each other prisoners by their mutual attraction, and, as the charge on each continues to accumulate, the particles of intervening air are raised to such a high degree of polarization that they fall into a state which is described as of "tottering equi-

* Journ. Soc. Tel. Eng., No. vii. p. 12. "Such amounts as we deal with in our great submarine cables would, if given to the earth as a whole, produce a very considerable electrification of its whole surface. The earth's radius is about six hundred and thirty million centimetres, and its electrostatic capacity is therefore six hundred and thirty million microfarads, or about that of sixteen hundred miles of cable."

librium;" the slightest change destroys this condition, and electric discharge follows with all the effect of light, heat, and mechanical energy.

An electrified cloud decomposes the combined electricity of every object over which it passes, repels the electricity of the same kind as that contained in itself, and attracts the opposite kind. The earth and objects beneath an electrified cloud are in this manner charged by induction. When the attraction between the opposite kinds of electricity becomes greater than the resistance of the intervening air, a discharge takes place. It is the accumulation of induced electricity on buildings, which offers the attraction for the opposite electricity contained in the electrified cloud, and causes them to be struck by lightning. The flash will pass along the line of least resistance at the moment when earth and air can bear the mutual tension no longer. Any accidental object may turn the scale. As Mr. Preece puts it, a ship sailing calmly over the ocean, a moving railway train, a horseman galloping home for shelter from the approaching storm, may be the last straw that breaks the camel's back.

Everybody knows the celebrated experiment of Franklin, by which he demonstrated the identity of electricity with lightning.

Franklin, when he sent up his kite, fastened a key to the string, and to the key a silk ribbon, intended (silk being a non-conductor) to isolate him from danger. For some time he was unable to perceive any appearance which would justify his theory; but a shower came on, the kite-string was wetted, and therefore became a good conductor. Franklin, in his impatience, presented his knuckle to the key, and was gratified by receiving a smart shock. It was lucky for him that his success was not more complete than it proved to be, for he would have paid dearly for the honor of his discovery.

He thought that his kite had withdrawn electricity from the thunder-cloud, whereas the discharge he witnessed depended on the inductive action of the thunder-cloud on the kite and string; he escaped destruction, because the electricity with which his kite and its string were charged was the small amount induced on them by the thunder-cloud.

Philosophers who followed in his footsteps did not escape so easily. Professor Richmann, of St. Petersburg, was killed by lightning in the following year. He had erected an apparatus in the air, making a metallic communication between it and his study, where he had provided means for repeating Franklin's experiments. He was describing to his friend, Sokoloff, the nature of the apparatus, and was stooping towards the electrometer to observe the force of the electricity, when a great white and bluish fire appeared between the rod of the electrometer and his head; at the same time a sort of steam or vapor arose, which entirely benumbed Sokoloff and made him fall to the ground. Several parts of the apparatus were broken and scattered about, the doors of the room were torn from their hinges, and the house shaken in every part. The wife of the professor, alarmed by the shock, ran into the room, and found her husband sitting on a chest, which happened to be behind him when he was struck, and leaning against the wall. He appeared to have been instantly struck dead; a red spot was found on his forehead, his shoe was burst open, and a part of his waistcoat singed.*

This dreadful accident was caused by the neglect on the part of Richmann to provide an arrangement by which the apparatus, when too strongly electrified, might discharge itself into the earth. If in Franklin's experiment lightning had really passed from the clouds to the earth, he would infallibly in like manner have been killed. People are very little wiser than they were in Franklin's time. At a recent meeting of the Society of Telegraph Engineers, Mr. Preece, one of our most distinguished electricians, spoke as follows:—

> When I go into country towns or places, and have a few minutes to spare, I invariably go to the church, not only to admire the architecture, but especially to see what sort of lightning-protection it is furnished with; and I am bound to say this: I have never been to one church yet where the lightning-conductor comes up to my notion of what a lightning-protector should be. . . . Sometimes it has no point and even no earth. Generally it is made of the most expensive copper rod; sometimes of the most inefficient iron tubes, broken in the middle; but in my experience of hundreds of churches, I have never seen one single lightning-conductor that I would pass as a lightning-conductor.†

Now considering the professional eminence of the speaker, and the fact that his remarks refer to no remote date, but were spoken on the 12th of May, 1875, it behoves us all to look to our defences. It

* Shaffner's "Telegraph Manual," p. 61.

† Journal of the Society of Telegraph Engineers, xi., p. 273.

seems almost incredible, yet we believe it to be the fact, that St. Paul's Cathedral, situated as it is in the heart of the city of London, was, until very lately, in an electrical sense, totally unprotected. During all the years since first it raised its golden crown over the murky atmosphere of Cheapside, until the year 1872, it was in such a condition that a single one of the thousand storms that must have played around it might have crumbled it to the dust. At its summit, on the exterior, there is a mass of metal weighing many tons, all of which was electrically insulated. The reverse, of course, should have been the case. The whole of these — cross, scrolls, and ball — should have been connected by some good conductor with the earth. Beneath the cross, and immediately below the great leaden dome, is a gallery of massive iron-work; still lower are the immense lead-covered surfaces of the aisle-roofs. All these were found to be so completely insulated, that if insulation had been an object to be attained by the utmost possible exercise of scientific ingenuity, it could hardly have been more effectually accomplished.* The lightning should by rights have found no resistance in its passage to the earth, whereas the resistance opposed to its course was nearly infinitely great.

Inside the building [said the same writer] we had, to tempt the lightning, the iron stanchions of the scrolls and ball; and around the whispering gallery were the immense iron gas-mains which supply the ring of jets immediately beneath the gallery. The sections of these mains are insulated from each other by the packing of the joints, and so are the successive sections descending the main shafts to the bottom of the building.

The writer goes on to show how the conductors originally put up to protect the building had been in the course of years eaten entirely away by rust, so as to afford great gaps which would have to be overleaped by the lightning, and so far no doubt the appointed means of safety entirely failed; but the sentence quoted above appears to us rather to indicate a source of safety than of danger. We cannot help thinking that the immunity enjoyed by the building for so many years was probably due in a great measure to the accidental circumstance of the iron-work of the whispering-gallery being connected, by means of the gas-pipes, with the enormous area of iron sewer-pipes of subterranean London. The writer of the account seems, however, from other parts of his article, to be so much the master of his subject, that we hardly think the sentence we quote was meant to imply exactly what the words appear to convey, for he could not have intended to say that the connection of the gas-mains with the whispering gallery was otherwise than a means of safety. Another expression in the sentence appears to point to adhesion on the part of the writer to a popular fallacy. The idea that metal "tempts the lightning" is unsupported by any fact, and is at variance with the whole course of experience. Lightning-rods do not attract lightning. Lightning is atmospheric electricity moving through bad conducting matter in an explosive form; metals are good conductors, and therefore the course of the flash will, in nine cases out of ten, pass along metals, because from their conducting properties they form part of the line of least resistance. But it cannot be supposed that an agency, which moves with such terrible velocity and irresistible force as lightning, could be arrested in its onward course and drawn aside by an insignificant piece of metal in the form of a lightning-rod. If metal did really possess the power of attracting lightning, the use of metallic eave-troughs, gas-pipes, water-pipes, speaking-tubes, bell-wires, and the thousand and one adaptations of metal in use in buildings, ought at once to be discontinued.

But this is not the case. So far from lightning-rods attracting lightning, an ideally perfect series of lightning-conductors would prevent the possibility of any disruptive charge within the limits of the action. The effect of lightning-rods is due to the fact that large quantities of electricity pressing upon small surfaces become quite unruly; and when the surface is reduced, as in the case of a lightning-rod, to a mere point, it gives rise to an escaping current and causes the electricity with which it is charged to diffuse itself in the air, much as a stream of water would do through the nozzle of a garden-hose. Points do not receive electricity from bodies with which they are not in contact; except in case of disruptive discharge, the silent flow is always from points, never towards them.

A good lightning-conductor offers a peaceful means of communication between the earth and the clouds; it leads the terrestrial electricity gently up into the sky and allows it to combine with its opposite without disturbance; but if the tension is too great to be thus quietly disposed of, the flash strikes downwards, and is led

* See an article in the *Telegraphic Journal*, August 1st, 1873, on the subject.

harmlessly to the earth by the conductor. A well-constructed conductor is uninjured by the flash, because if offers but small resistance. But if in any part of the circuit between the electrified cloud and the earth there is an interval of badly conducting material, or if there is any break in the continuity of the conductor, the lightning will leap over, rend, and shiver to atoms anything that opposes its passage.

Owing to the affinity of electricity for points, when an electrified cloud passes over a building electricity will accumulate with most intensity upon ridges, gables, and finials; for this reason all such objects should be connected with the lightning-rod, and the rod itself should be fastened to the walls, instead of being, as is too often the case, insulated from them by glass. In short, the great object is to present such a number of points to the electrified cloud as to neutralize it, and prevent the necessity of disruptive discharge; if, after all, an explosion should ensue, the lightning-rod will form the line of least resistance, and afford the means of harmless escape to the earth. A good lightning-conductor should have a sharp point, be continuous without fracture throughout, and have its end buried deeply in moist earth. In fixing a conductor, a hole should be dug deep enough to reach earth permanently moist, or, failing the possibility of this, it should be fixed to a considerable quantity of old iron, or an iron drain-pipe. But this is a much less desirable plan. It is very commonly the custom to lead the end of the conductor into a tank. For purposes of safety it might as well be attached to the ironwork of the proprietor's bed. If the tank is full of water, the cement, preventing percolation through its sides and bottom, would to a great extent, insulate the earth-connection; if the tank is dry, the conditions are still worse, for there is then no "earth," in an electrical sense, at all. We are told of one instance in which a gentleman coiled up the end of his lightning-rod, and put it into a bucket in his cellar, apparently under the impression that the water would extinguish the lightning. Another point to be noted is, that galvanized-iron rope forms as efficient a conductor as the expensive bar of copper which tradesmen usually recommend. "Remain indoors during thunderstorms," says a writer on this subject, "keep out of cellars, and avoid being near trees during the passage of electrified clouds. In case the gas or water pipes of the buildings are not connected with the lightning-rods, it is not safe for a person to remain in a position in which his body would become part of the line of least resistance between them. Beds should be removed from the walls. Persons in chairs should be in the centre of the room and keep their feet off the floor." We imagine, however, that only very nervous persons will think it necessary to obey all these instructions to the letter.

If a discharge from an electrified cloud takes place from any cause whatever, at any point, the cloud is left in a neutral condition. Induction ceases, and all the bodies charged by induction instantly return to a neutral state. The suddenness of this return constitutes the dreaded "return stroke," which often destroys buildings and animal life at a great distance from the place where the direct charge takes place, and is often more fatal than the direct discharge. A curious circumstance, which was the subject of discussion at one of the meetings of the telegraph engineers, affords an apt illustration of this. A gentleman named Pidgeon, with his wife and son, were on the grass-plat of their house at Torbay close to the seashore, when a violent and sudden thunderstorm destroyed the flagstaff near which they were standing, and inflicted injuries more or less severe on all three of them. As many of the principal English electricians took part in the discussion which followed the reading of the account, and it seemed to be pretty generally the opinion of the authorities that the effects on Mr. and Mrs. Pidgeon were due to the return stroke, we will tell the story.

Mr. Pidgeon and his family were looking out to sea, and watching an approaching thunder-cloud. Suddenly, with a crash that was compared by bystanders to the explosion of a three-hundred-pounder gun, the lightning broke over the mast, which was shivered to atoms. Fragments of it were forced one hundred and fifty yards to windward, showing that great mechanical force must have been developed at the time of the discharge. Of the effects on themselves, we must allow Mr. Pidgeon to speak. We extract from a letter written by him to *Nature*, and reprinted in the "Journal;" *—

Of the three, my wife only was "struck," and fell to the ground, my son and myself remaining erect, and all three lost consciousness. For more than half an hour my wife lost the use of her lower limbs and left hand, both of

* Journal of the Society of Telegraph Engineers, May 12th, 1875.

which became rigid. From the feet to the knees she was splashed with rose-colored tree-like marks, branching upwards, while a large tree-like mark, with six principal branches diverging from a common centre, thirteen inches in its largest diameter, and bright rose-red, covered the body. I had almost forgotten to mention that my wife had just closed the lower door leading from the garden to the shore, and was looking over it out to sea. The iron bolt which fastens this door is *exactly* the same height from the ground-line as the mark on my wife's body . . . As I turned to help my wife, who was on the ground, I shouted, as I thought, that I was unhurt; but it seems I only uttered inarticulate sounds, and my son in his first attempt to answer did the same.

It was very truly remarked on the account, of which the above is a brief extract, that if the Pidgeon family had been struck by lightning they would not have been there to tell the tale. The probability was that they, as well as the flagstaff, were strongly charged with induced electricity by the advancing cloud. When it reached the flagstaff — and, coming from the sea, the flagstaff is the first object it would encounter — a discharge took place, and Mr. Pidgeon and companions returned to the neutral state so rapidly as to cause severe inconvenience. In the *Telegraphic Journal* is published a drawing which is described as a "facsimile of chief marks made by the discharge on Mrs. Pidgeon," but on the subject of its exact resemblance we have no certain information. We should have thought that printers' ink could hardly produce a facsimile of a rose-red object. But we must not allow imagination to carry us too far. We content ourselves with the remark that the design is remarkably elegant.

Of all the recent developments of electricity, the submarine cable has, perhaps, exercised the greatest effect on modern life. Its history and mode of manufacture have been in recent years so much before the public, that most people have accurate general ideas on both these subjects. But there are a few points connected with the working and maintenance of sub-oceanic cables, on which information is not so readily attainable. For instance, it is curious how little is known of gutta-percha. This substance, which is the dielectric in most ordinary use for separating the conducting wire of submarine cables from the ocean bed on which it is destined to repose, is the concrete juice of the *Isonandra gutta*, or taban-tree. It grows to a height of sixty or seventy feet, in alluvial soils, at the foot of hills in the Malayan Archipelago, in southern Asia, and in Dutch Guiana. The chief supply has hitherto been obtained from Singapore. We are told by Mr. Douglas, that the words *gutta percha* are Malayan; the former signifies gum or concrete juice of a plant, the latter the special tree.

When first this substance was introduced into England, and before the manufacture of telegraph cables made it an article of such primary necessity as to require economy in its use, it was the practice to fell the tree, and cut rings through the bark a foot or eighteen inches apart; the milky juice was received in suitable vessels, and inspissated by boiling. Eventually the matter was taken up by an English company, and the juice is now obtained in the same way as caoutchouc or india-rubber. It arrives in Europe in blocks several pounds in weight, and is generally found to be adulterated with sawdust, earth, and other impurities, introduced by the native producers to add to its weight. This adulteration offers one of the most serious difficulties encountered by the cable-manufacturers. Elaborate and expensive machinery has to be employed, in order to reduce it to the absolute purity required to permit its use as an insulator.

The blocks of gutta-percha are often rudely fashioned by the native workmen into grotesque imitations of animals, men, or deities. We have sometimes seen these so well executed as to make it almost a pity not to keep them as curiosities, rather than cut them up into shreds and plunge them into boiling water, preparatory to passing them through the ruthless masticating machines. Even now the processes in use in the best cable-manufactories are rude and inefficient; and a method of manufacture has been patented by a well-known London dentist, which would no doubt at some future time revolutionize the working of gutta-percha, were it not that the saving and improvement effected has not hitherto been found to counterbalance the expense of discarding the present expensive machinery. Circumstances, easy to be understood, have reduced the manufacture of insulated telegraph wires to a virtual monopoly, in the hands of a few firms who can supply the limited demand without altering their existing plant. We have already seen to what extent the inductive action of gutta-percha retards the transmission of messages through the wire it covers. It is

supposed, with a great show of probability, that increased purity of material, consequent on improved methods of manufacture, would diminish the inductive capacity, and consequently promote greatly increased speed of transmission.

Other objects of curiosity are the instruments employed at the seashore termini of submarine cables for transmitting signals under the ocean. Our readers are probably acquainted with the principle on which the signalling apparatus in use on land lines is constructed; it will be sufficient to remind them in general terms that most of these depend mainly on the discovery, by the German philosopher Oërsted, of electro-magnetism.

About the year 1820, there occurred to Oërsted one of those brilliant accidents which, happening to a mind prepared to seize their significance, ripen into great discoveries. He was engaged in some electrical experiments with a voltaic battery, and held a small mariner's compass in his hand. He observed that the compass was deflected as the current passed. He repeated the experiment, and found that the effect of the current varied, according as the current passed above, below, or around the magnetic needle. It was soon ascertained that the magnetic needle had a tendency to place itself at right angles to the direction of the current. By a brilliant effort of inductive reasoning, Oërsted sprang to the conclusion that the magnet obeys a constant directive action of the earth, caused by electric currents constantly passing the magnetic equator from east to west, and that the magnetic needle, subjected to the action of a current could, as his experiment showed to be the case, be moved at will; because the motive force, being nearer, and consequently more powerful than the ordinary terrestrial magnetism, overpowered the directive action of the earth. The identity of electricity with magnetism was thenceforth established.

Oërsted's experiment was soon followed to new and startling conclusions. The needle, it was observed, always placed itself in the same position relatively to the direction of the current. That direction may be best understood by an illustration.

If the wire were a canal, and the reader were swimming along it in the direction of the current, the north pole of a needle would always be deflected, to his left hand if placed before his breast, and to his right hand if placed behind his back.

It will be perceived from this, that if the wire is bent round the needle, its two halves act in the same direction, and the effect is doubled. If the wire be bent a second time round the needle, the effect will be again doubled, and a still further increase in the number of turns will produce a corresponding increase of force. If, then, a wire, covered with silk or gutta-percha, or other insulating material, is wound several times round a needle, and the current is thus compelled to pass along its whole course, at such a distance from the needle as to direct its action without touching it, the force of the current is multiplied in proportion to the number of turns.* A comparatively feeble current is thus able to effect great results. This, it will be seen, is, in fact, the modern telegraph. Currents of negative and positive electricity are sent along the line-wire, and passed at the receiving end round a magnetized needle. The result is the alternate right and left deflections with which every frequenter of railway stations is now so familiar.

On this principle, too, instruments for measuring currents are constructed. The simplest kind of galvanometer consists in a magnetized needle placed in the centre of a hollow frame filled with covered wire; the degree to which the needle is deflected (as shown on a graduated scale which is centred on the needle pivot), indicating the quantity of electricity passing through the coils. The differential galvanometer differs from this instrument, in that it measures not the absolute strength of a current, but the difference of strength of two currents. Its wires are wound in two coils side by side; they are so arranged as to be exactly equal in their effects upon the needle. When two equal currents are made to pass in opposite directions through the coils, they will exactly balance one another, and the needle will not move. but if one current be stronger than the other, the balance will be destroyed, and the needle will obey the stronger, to an extent determined by the difference of strength of the two currents. The use of the differential principle will be very apparent when we come to the subject of duplex telegraphy. A wire through which a current is flowing, possesses for the time properties similar in many respects to those of a magnet. It attracts iron filings, attracts or repels the poles of a magnet,

* The action of the current cannot be multiplied indefinitely, because the intensity of the current diminishes as the length of the circuit increases. So if the wire is too long the current becomes very feeble, and at last there would be no current left to multiply.

and acts upon other wires through which currents are moving. If, instead of passing round a magnetized needle, the wire is twisted round a bar of soft iron, the iron core becomes magnetic, and acquires for the time much greater power than it is possible to give to a permanent magnet. A current after traversing a line-wire can be made to electro-magnetize a bar at a receiving end, in such a manner that, in virtue of its temporary magnetism, it attracts a lever attached to its armature, and puts a fresh battery into circulation. By this means a current too feeble to record intelligible signals may be made to renew its strength over and over again, and transmit itself, strong and clear, through a circuit of length otherwise unmanageable.

Perhaps it would be as well to say here that a "circuit," telegraphically speaking, comprises first the earth, then batteries and other apparatus at the terminal station, then the line, and so through the other terminal apparatus and batteries to the earth again. Intermediate stations are introduced by cutting the wire, and placing the instruments between the divided ends. In the same manner a box of resistance-coils, shunts, or any kind of conductor may be interposed at any point of the circuit.

Steinheil was the first to employ the earth as a substitute in a telegraphic circuit for a return wire. He buried two copper plates, one at each station, and connecting the extremities of his telegraphic lines to these plates, he found that signals could be transmitted with as much facility as when a return wire was used. In fact, a circuit will work to a much greater distance when it is composed of half wire and half earth, than when it is composed only of wire.

It may readily be seen that as each mile of cable offers a certain resistance to the passage of the current, and each mile is subject to its own inductive retardation, the cumulative action of these causes through two or three thousand miles of cable so weakens the current that it retains but a small fraction of the strength with which it left the battery. So feeble is it, that it is unequal to the task of electro-magnetizing an ordinary relay — an operation which, as performed on land lines, we have already described — nor is it strong enough to work even the lightest needle which could be suspended at the receiving end.

It is to the genius of Sir William Thomson that we owe the solution of this apparent impossibility. He attached a magnetized needle to a tiny mirror (mirror and needle together weighing scarcely more than a grain), and suspended it by a single fibre of unspun silk within the coils of a galvanometer. A cardboard screen was placed in front of the mirror, in which was perforated a narrow slit, and behind this he placed a lamp. The light from the lamp was reflected through the slit, on to the mirror and thence back in the shape of a pencil of light to the screen. When the mirror galvanometer was connected with the line-wire, and a current, however feeble, passed through its coils, the needle and mirror were deflected, and the reflected beam of light moved along the scale. By this arrangement, even though the movement of the needle should be so minute as to be quite imperceptible to the eye, the reflected beam moves through a very sensible arc on the screen, and the ordinary right and left signals of telegraphy can thus be easily given and clearly read.

We have, of course, only given in mere outline the principle of this delicate instrument, which is adapted to practical work by many beautifully simple arrangements. But the main idea of making an imponderable beam of light do the duty of a heavy lever has alone made ocean telegraphy a possible feat. Another point of general interest is the manner in which electrical tests are performed. It does not at first appear easy to imagine how the position of a break or fault in a cable, hundreds of miles away under the sea, can be discovered with such precision that a repairing ship can be sent to the very spot. Here again we can only indicate a principle, the practical working is far too complicated to be understood without minute and careful examination, and the use of diagrams. But the principle may be made clear, and will give a good general idea of the *modus operandi*. It is all effected by a careful comparison of resistances. Those who have done us the favor to read the earlier part of this paper will understand what is meant by the resistance of a given circuit, and will also be acquainted with the construction and use of the instruments principally employed, namely, galvanometers, boxes of resistance-coils, and condensers of known capacity.

If a needle be suspended between the coils of a differential galvanometer, and a current be sent through one of them, the needle will be deflected, say, to the left. A current of exactly the same strength as the first, sent simultaneously through the other coil, will cause the opposing cur-

rents to neutralize each other, and the needle will remain at rest; the box of resistance-coils accords to the operator the power of placing in the path of the current any required resistance, from the tenth of an ohm up to forty thousand ohms, or more, by simply inserting or removing metal plugs in holes made for the purpose in the lid of the box. If, then, to the right-hand galvanometer-coil be attached the box of resistances, and to the left-hand coil the line-wire requiring to be tested, all the operator has to do is to shift the resistance-plugs till the line and the resistance-box balance each other on the galvanometer. He then reads off the resistance which has brought the galvanometer to a standstill, and as he has made the two equal, it follows that he thus knows the resistance of the line-wire. Constant tests, made during manufacture and afterwards, have made him familiar with the exact resistance *per mile* offered by the line-wire; so that dividing the total resistance by the resistance per mile, he obtains the length of wire under examination. Suppose the resistance per mile to be four ohms, and the resistance which has produced a balance at the galvanometer is forty ohms, it follows the length of wire under examination is ten miles. Now, assume that the matter to be ascertained in the above test was the unknown position of a "fault," you discover that the circuit was completed by the escape of the current to earth at a distance of ten miles; you have thus determined that the naked end of the cable touches the earth at that distance, and that the fault is an absolute break in the cable ten miles away.

It need not be said that this is testing in its simplest form; we have omitted all collateral circumstances which in practice would obscure the result, and make an apparently simple into a difficult operation. It is a very different matter when the fault is a mere flaw in an otherwise perfect cable, but this is the principle. Tests are taken hourly during the manufacture of a cable, to determine that it is electrically sound throughout, and that the insulation is complete. To ascertain the latter point, that is to say, that there is no leakage of electricity through the gutta-percha covering, the wire is first suddenly charged from a battery, and as suddenly discharged through a galvanometer. A certain deflection of the galvanometer needle is thereby produced, and noted as deflection No. 1. It is then charged a second time, and left for a few minutes, at the end of which it is again discharged through the galvanometer, and deflection No. 2 is noted; the difference between deflection No. 1 and deflection No. 2 corresponds to the amount lost by leakage during the time the wire remained charged.

It may easily be imagined that the tests are never more anxiously performed than when the cable, duly completed, and coiled in great tanks on board the telegraph ship, is being slowly paid out into the deep. Every minute signals are passed from the shore to the ship, through the gradually increasing length of submerged line, through all the thousands of coils which lie piled, tier above tier, in the cable tanks, down to the testing cabin. There the electrician on duty sits with his mirror galvanometer, watching the reading-screen, where the movements of a small spot of light give him tidings of the shore he is leaving. The whole interest of a great and costly expedition is thus centred in the little quiet testing-room.

The operations, both of the ordinary working of submarine telegraphs and the testing operations, are much complicated by earth-currents. Very often, especially at the time when the phenomena of the Aurora Borealis are prevalent, strong currents pass over the lines, entering by one of the earth-connections, and leaving it by the other. They are never constant for long together, and they change direction so rapidly as seriously to affect the delicate instruments in use on submarine lines. They are most violent during magnetic storms, which seem in some mysterious manner to be dependent upon the aurora, which, in its turn, is a manifestation of some ultimate cause of which nothing positive is known. Observation shows that earth-currents are frequent at the time of earthquakes; the "Journal of the Society of Telegraph Engineers" contains constant notes of these coincidences, observed by the ever-watchful members of the society. Many of the most distinguished electricians think that the sun is the ultimate cause of this, as of all other forms of terrestrial magnetism, and it certainly seems probable that such is the case. It is well known that the period of maximum and minimum of spots on the sun extends over a cycle of eleven years, and during that time the aurora becomes proportionately more or less intense. "In 1850," says Mr. Latmer Clarke, "two simultaneous observations of the sun were made by observers many miles apart, when both saw a body flash into

the sun and cause a disturbance of the sun's chromosphere; and it was subsequently found that at that moment almost all the magnets of the world were disturbed by this sudden movement." * The fact that the cause and effect were apparently simultaneous incidentally confirms the inference that the velocity of the transmission of magnetism is the same as the velocity of the transmission of light.

Sometimes the earth-currents are of enormous power. In 1871, a break having occurred in the Atlantic cable, Mr. Graves was able to devote a great deal of time to the investigation and tabulation of the earth-currents which appeared on the broken line. At one time during a great magnetic storm, which was felt all over the world, Mr. Graves, who was observing at Valentia, saw currents of such strength, that "a distinct arc of flame burned between the key and the earth-connection." The power necessary to produce this he estimated at not less than two thousand cells of Daniell's battery. The late Admiral FitzRoy found the indication of coming storms predicted with singular fidelity by magnetic disturbances of the earth. He could sometimes see the approach of a storm days before the barometer and thermometer indicated anything of the kind. The ordinary observations of the telegraph-operators confirm this. They can actually feel a storm coming across the Atlantic for days beforehand, by the increasing vagaries of their troublesome visitor, the earth-currents. It is not improbable that observations may eventually be found susceptible of such generalization as to afford really reliable weather forcasts.

One of the latest telegraphic marvels is the arrangement by which it is made possible to send two separate messages along the same wire in opposite directions at the same time. This is known as duplex telegraphy; and perhaps nothing connected with the practical working of telegraphs has excited more wonder, and been found more difficult to understand. The first question which is naturally asked is, How can the currents pass one another in the line-wire? and, if they do pass, how is it that they do not interfere one with another? If, however, we have been fortunate enough to make clear the principle of the differential galvanometer, the difficulty will vanish. In sending an ordinary message, the current passes from the battery at the sending end through the instrument at that end, along the line, through the instrument at the receiving end, and so through the earth back to the battery from which it started. In doing so it of course moves the instrument at the sending end, as well as the distant one; for it passes through them both. Now suppose that the operators at both ends were to dispute for the possession of the circuit, and send opposite currents simultaneously through the wire, the result would be hopelessly to confuse the signals, and make reading impossible; but if the operators were to set to work to unravel the apparent confusion, they would soon find that when station A and station B, in the course of their confused struggle for the possession of the line, happened to send a current in the same direction, the needle acted upon would strike the stops with double force, while, if they sent in opposite directions, the needle would hardly move at all. Thus each operator would be able to perceive that the signals of the other station were *visible* on his instrument, and were only prevented from being *legible* by the confusion introduced by the current he himself was sending along the wire. It would doubtless occur to them that if by any means each could so arrange that neither station's own or outgoing currents should affect his own needle, leaving the dial free to show only the effect produced by the incoming current, the difficulty of reading would vanish. The question then arises, How can each instrument be so connected that neither sender shall move his own needle, and yet so that the coils shall always remain in circuit?

Now, in a differential galvanometer, if two equal currents are simultaneously sent through the two coils in opposite directions, the result is that the needle stands still. Apply that principle to the line in such a way that the current, when either end makes a signal, shall at that end divide itself into two, and the two halves pass round the sending instrument in opposite directions. This will only happen when the two half-currents are exactly equal, which will only be the case if the two circuits they have to travel are equal. To effect this, one half-current must pass along the line-wire to earth, and the other half be sent to earth through a resistance exactly equal to the line-wire.

When the balance is established, neither sender, when he signals, will move his own instrument, which will be left free to record signals from the opposite side; but the operator at the other end will be able

* Journal of the Society of Telegraph Engineers, v. 121.

to read them, for each station will see the current sent by the other, though neither can see his own.

It will be seen that the two currents do not pass one another, as has been imagined, but that, when both stations signal at the same time, the current sent by either station acts upon the distant instrument by determining whether the currents sent by that station shall pass through the line or the resistance-coils.

On land lines suspended in the air the resistance of the signalling-wire to the current is easily ascertained, and is easily imitated on the second or artificial circuit; but in submarine lines there is not only the resistance to be taken into account, but the retarding capacity of the cable. In any given cable each mile presents a certain resistance, and also a certain retarding capacity. The second circuit on land lines need only imitate the resistance, but in cables the retarding capacity must also be imitated. It is not enough that the whole of the second circuit should be equal to the whole of the cable, but that each separate part of it should be equal to each corresponding part of the cable. The latest plan, which seems at length to have made duplex working in submarine wires practicably possible, is that adopted by Mr. Muirhead. He forms his second circuit by sheets of paper, prepared with paraffin, as an insulator, having on one side a strip of tinfoil wound to and fro to represent the resistance, and on the other a sheet of tinfoil to represent its retarding capacity. Each strip of paper may thus be made to represent precisely a given length of cable; and a given number of such sheets would exactly imitate the cable in every part of its length; so that the non-signalling half of the current sent through the artificial resistance escapes to earth under precisely similar conditions to that which passes over the line.

The result of this is that a single wire will convey signals simultaneously in two opposite directions, and that one wire will do the work of the two which have hitherto been required. On all marine lines this invention is of the greatest possible importance, because while theoretically it only doubles the carrying capacity of each cable, in practice it does a great deal more; as it does away with the loss of time consequent on arranging about the precedence of outward and homeward messages.

The method was first tried on the line between Marseilles and Bona, and it has since been brought into operation between Marseilles and Malta, between Suez and Aden, and, lastly, between Aden and Bombay. It is stated that on a recent occasion, when there was a breakdown of the Indo-European line, the duplex system became of the greatest possible use; and although there are still practical difficulties to be encountered before it can be adopted in lines where very long distances have to be accomplished without a break, there is no doubt that the theory is so well established that its universal adoption is only a question of time.

"The telegraph," says Sir Lintorn Simmons, "is an essential in war; war can scarcely be carried on without it." Mr. George Von Chauvin, who was secretary to the German director-general of telegraphs during the Franco-German war, appeared as a witness before a committee of the House of Commons on postal telegraphs last year, and gave a very animated account of the way in which that service was performed by the German army during his period of service. He tells us that the telegraph was in constant use for the arrangement of the transport of ammunition; of the whole service of the commisariat; the transport of wounded soldiers and prisoners; for the regulation of traffic in the field railways, which was very heavy, and which frequently necessitated the shunting of ammunition trains to let a train of wounded soldiers go by, or stopping a train of soldiers to bring up ammunition. It was also used for the investiture of fortresses like Paris and Metz, where it would have been impossible to have an army large enough to girdle round the whole enceinte. The lines of attack round Paris extended some twenty German (above ninety English) miles; the field telegraph was used along this extended line to bring together troops whenever they were wanted, either to repel a sortie, or to make an attack. It was also used to keep the various corps of the army, operating in the centre, north, and south, in permanent connection with the headquarters' staff at Versailles. Telegraphs also accompanied and kept up the communication of all detachments of independent corps, brigades or divisions, which operated independently against the smaller forces of the enemy. Thus immediate information was conveyed to headquarters whenever an engagement took place within any of the ramifications of the gigantic spider's web, of the number of troops engaged, the result of the contest, and its probable effects; and new orders

were given as to fresh steps to be taken. It may easily be believed that it was perfectly recognized by the German officers that the war could not have been conducted on this scale at all without the assistance of the telegraph.*

The Germans had acquired telegraphic experience in two former wars. They consequently entered on the Franco-German campaign with a very complete organization. They used three kinds of telegraph: the first, which was taken into the immediate proximity of the enemy; the second, the duty of which was to keep up communication between the advanced army corps and their basis of operation; and the third, the ordinary telegraph of the State. The whole system was under the command of a colonel of the royal engineers, attached for service to the telegraph department of the State; the officers under him were officers of the royal engineers, the men mostly soldiers, but not necessarily engineers. They were taken from all arms, and a good many of them were employed as civilians in the ordinary time of peace. The duty of the advanced part of the field telegraph was to push on into the close proximity of the enemy. They did the service in the trenches before Paris, and carried on the work of communication whenever an action was going on. The telegraphists employed in the Prussian army during the war were trained in the State telegraphs: the soldiers taken from the ranks during the time of peace were put for a certain time into the offices of the State telegraph department, and did the usual work of telegraph operators, linesmen, battery-men, and the other ordinary duties of telegraph departments. In peace-time they were placed under the command of civil-service officers, and there was practically no distinction between them and the ordinary civilian who was employed by the government. But this was the smallest class of trained military telegraphists employed by the Germans; a very large class were at once soldiers and telegraph-men.

In Germany, as formerly in Prussia, a soldier who has served his time as non-commissioned officer, and bears a good character, is entitled to employment in the civil service. By that means not only does the army obtain a better supply of men for its non-commissioned officers, but it furnishes to the telegraph department a large class of men who, although not very smart operators, are yet very trustworthy, and, for the purposes of war, are perfectly indispensable. "I do not know," says Mr. Von Chauvin, "what proportion of our ordinary telegraph-operators in Germany have formerly served for a lengthened period in the army, but I should think it is a very large one, and the difficulty which we found whenever war broke out was not how to offer an inducement to our telegraph-men to join the troops, but how to console those who were ordered to remain at home. They all wanted to go."

The material used in the advanced telegraph services was exceedingly portable. Very light copper wire, light poles, which could be stuck into the ground by not too great an effort of a man ramming it down, and a large quantity of wire insulated with india-rubber, which was rolled out as necessity arose. The department was furnished with wagons, such as are in use now in England, containing instruments, a small battery, a certain amount of wire, and accommodation for an operator to sit and to write in. The wagons could be taken about by a couple of strong horses at a pretty rapid pace; and the wire could be rolled out as it went along, and thus keep up communication with the troops behind. The second class of field telegraphs were what is called in Germany *Etappen* telegraphs; their duty was chiefly to maintain telegraphic communication between the advanced heads of the army corps, and these places which, having been made depots for ammunition, or hospitals, formed the basis of operation for the more peaceful part of the warfare; there they linked on to the ordinary telegraphs of the State, which extended its ordinary strong and well-built lines over the frontier as the army advanced into France. As the Germans gradually introduced their postal sytem, sanitary arrangements, judges, and all the necessary machinery of civil government, they also introduced the State telegraph system, which was thus kept in communication with the outposts. These three corps might be compared to light skirmishers, to a more solid advancing line, and then a solid mass of reserves. The materials which they used were very light in the first instance, were of intermediate size and quality for the second class, and were the ordinary heavy materials for third class.

When Mr. Von Chauvin was asked whether in his opinion soldiers must be specially trained for telegraphic services in the field, and whether civilians could not

* Evidence before the House of Commons (Postal Telegraphs), page 100.

supply their place, his answer was, that he believed a soldier would require a good training to be of any use as a telegraphist, and that a civilian would, as a rule, be of very little use. It would be very difficult and very irksome to place him under martial law, and operations cannot well be conducted in an enemy's country without having everybody under your command under martial law. It was also found by the Germans, as well as by ourselves, that, again, you cannot expect a civilian who has made up his mind to be a telegraphman for the rest of his life, and to work in a peaceful occcupation, to sit in front of an enemy who is firing at him, and risk his life for the purpose of sending a message; whereas a soldier, who makes up his mind when he joins the army to run the risk of being knocked on the head, will sit down to his work under fire without remonstrance, and in the ordinary course of duty.

The opinion expressed by Mr. Von Chauvin as to the competency of civilians to work the telegraph in the vicinity of a hostile force was strongly confirmed by Sir Lintorn Simmons. He referred to the case of a civilian force in the Crimea, namely, the Army Works Corps, in which great difficulties occurred in carrying on the necessary works.

The organization of the military telegraph department in this country does not differ very greatly from that adopted by the Germans. The nucleus of the force is a small body of Royal Engineers under their own officers, who in time of peace have charge of what is called "the eastern engineering division" of the postal telegraphs. They have under their charge nearly ten thousand miles of wire, and their *personnel* consists of four officers and forty-three non-commissioned officers and sappers, besides a few occasional additions to assist in the ordinary construction and maintenance work. These employés correspond to the ordinary division of the civil force. The senior officer takes the duty of divisional engineer; the next officers, captains and lieutenants, take the duty of superintendents; sergeants-major and sergeants take the duty of inspector and chief clerk; the corporals take the duty, as a rule, as clerks. The sappers become linesmen, storemen, and mechanics.

In the "Journal" is found a very amusing account of the construction of the telegraph used during the Ashantee war, from the pen of its constructor, Lieut. Jekyll, of the Royal Engineers. At first, as will be remembered, it was intended to carry on the war by the aid of native levies alone, without the intervention of any Europeans. But a few days were sufficient to show that the idea of a railroad which was first contemplated was impracticable from the nature of the country, and that the idea of native levies was impracticable from the nature of the people. On landing at Cape Coast Castle, Sir Garnet Wolseley found it necessary to resolve on a total change of plan. He sent for English troops, countermanded the railroad material, and ordered a telegraph instead. So short was the notice, that the supply of stores could not be got ready in time to accompany the troops. The detachment, therefore, of twenty-five non-commissioned officers and sappers, started with such stores as they were able to collect on the instant, leaving the main bulk of their preparations to follow. Lieut. Jekyll, on his arrival at Cape Coast Castle, at once proceeded up country, and, armed with a bag of silver coins, bought a supply of bamboos from the chiefs to form posts for his telegraph wires. Starting from a shackle on the roof of Government House, the line proceeded in the direction of Coomassie at the rate of about two miles a day.

Lieut. Jekyll says of his native workmen, "We were now furnished with a gang of fifty natives, whom we were to retain permanently, that is if we could. They were not promising in appearance, and I was compelled to dispense with the services of those who were less than four feet high. But they had with them an intelligent headman, and by dint of supervision, supplemented by a little flogging now and then, they soon turned out a tolerably useful body for light work, as niggers go." The line ultimately extended to Accrofumu, about one hundred miles from the coast.

The telegraph was regarded as the white man's fetish, and was looked upon as a most powerful charm. Shortly after crossing the Prah, the advanced parties discovered a white cotton-thread suspended from the trees, obviously in imitation of the line, for a distance of several miles. Part of this respect was, no doubt, owing to the fact that the workmen in making the line received several smart shocks of lightning while handling the wire. Lieut. Jekyll was at one time afraid that he would suffer serious inconvenience from that cause. One of the greatest difficulties to be encountered was naturally the climate. Many of the Europeans, including Lieut. Jekyll himself, were at one time down with fever. At one office the sapper operator

was so ill with fever that he lay in bed in his office, with a black fellow to rouse him up whenever a message came which claimed his attention. Recording, that is, printing instruments, were principally used. But in the discussion which followed the reading of Lieut. Jekyll's paper, a great preference was expressed by the officers present for the sounder, which addresses itself to the ear. A quaint practical difficulty which was urged in favor of the recorder, was that in fever districts the operators got deaf from the effects of quinine, and were unable to hear the sounder. In reply to which, a distinguished member of the society triumphantly told a story, which, we are bound to admit, was received according to the report with "laughter," of a blind girl who was able to read by smell: —

"She placed her nose," said the speaker, "above the instrument, which was Bain's chemical recorder, and thus cyphered the despatch."

The task of organizing the field electric-telegraph equipment was undertaken at Chatham, and we now possess specimens of carriages and apparatus which seem well adapted for the purposes required to be fulfilled in a-light equipment. The instruments employed are Morse recorders and sounders, arranged in a very portable form. The batteries are modifications of Daniell's, and the conductor is Hooper's core. A few light iron telegraph poles are also carried for special purposes. The instruments, batteries, etc., are fitted in travelling offices, which are simply telegraph offices on wheels, and the conducting-wire poles, etc., are carried in wagons adapted for the rapid construction of a line telegraph. The conducting wire is arranged to be laid on the ground at a minimum rate of two miles per hour; with well-practised men a line has been constructed at a rate of four miles in an hour and a quarter. This insulated cable is not like the Prussian, susceptible of injury by the passage of heavy wagons over it, and it has stood some very severe tests in that and other respects without injury. The light iron poles are for use at road-crossings, where continuous heavy traffic would in time produce injury. Spikes of a peculiar form are also carried to enable the conducting wire to be suspended to trees, or walls, in order to meet the contingency of passing through a town or village.

We have left ourselves no space to make more than a passing allusion to the use of the torpedo in warfare. Indeed, the whole subject is still so much a matter of experiment, and is so far from having arrived at the point when it can be treated with any completeness, that it would not be easy to do more than detail experiments, even if we had space at our disposal. In the report of the secretary of the United States navy, published as far back as December 1865, when the torpedo system was only in its infancy, and manipulated by the Confederate engineers under every possible disadvantage, it is stated that when the United States fleet attacked Mobile and Wilmington, the sea defences of which mounted more than six hundred guns, although the shore batteries of the Confederates were splendidly served, the only vessels lost by the United States government in both these attacks, were destroyed by electric torpedoes.

The important defence of the water approach to Richmond was entrusted to a single electric torpedo, sunk in the channel-way of the James River. The mine was under the control of an officer, who, stationed on one of the river banks, watched from the sand-pit where he lay concealed the approach of the enemy. A single stake planted on the opposite bank served to indicate the exact moment when an approaching vessel would be within the area of destruction. With the patience of a spider watching its victims, for thirteen months did this officer watch the opportunity to explode the mine with effect. At length the Federal fleet, under the command of Commodore Lee, entered the James River, the commodore's vessel being third in the advancing rank.

The foremost vessel, carrying seven guns, and manned by a picked crew of one hundred and twenty-seven men, was allowed to pass over the mine in safety, it being by arrangement held in reserve for the commodore's ship: but an order having been passed from the deck of the next ship, audible from the shore, to return and drag for torpedo-wires, the officer determined to explode his mine as she descended the stream. The explosion took place on a clear afternoon, and was witnessed by many persons. The hull of the vessel was visibly lifted out of the water, her boilers exploded, the smoke-stacks were carried away, and the crew projected into the air with extreme velocity. Out of the crew of one hundred and twenty-seven men, only three remained alive, the vessel itself being blown to atoms. The awfully sudden destruction of this ship saved Richmond for the time. Commodore Lee retired, sinking several of his ships to block up the channel.

Torpedoes are now so improved, that after they are submerged the operators on shore retain the power of the submarine and land circuits without fear of explosion, and are even able to speak and telegraph information through the charge without risk.

Every torpedo consists in its complete form of three parts; the ignitor, the charge, and the torpedo case or tank, together with the necessary arrangements for electric connections and conductors for giving the operator the entire control of the mine. The importance of accuracy and precision of ignition at sea will be easily understood, by calculating the length of time the enemy remains in the line of vision. A vessel steaming at the rate of nine miles an hour will move through the water at the rate of eighteen feet per second; and supposing her to be three hundred feet in length, she will remain in a position to receive the effects of a blow only sixteen seconds. One thing may be considered entirely proved, that for shore defences the old form of mechanical torpedo may be considered as quite superseded by the application of electricity to the purpose.

We had hoped to be able to give some account of the underground and overhead system of the postal telegraph in London and our great towns; but the subject would require a paper to itself, and our space is exhausted. We have not even room to discuss the system by which daily meteorological observations are transmitted from a hundred stations to the Royal Observatory to be tabulated and arranged. For a similar reason we must leave unnoticed the application of the electric light to the lighthouses on our shores, the use of electricity as applied to clocks, and the system of time-signals daily transmitted from the Royal Observatory to our naval arsenals and ports. We only enumerate them here to give point to the observation how completely this, the newest of the sciences, has entwined itself with the every-day business of life.

From Good Words.

DORIS BARUGH.

A YORKSHIRE STORY.

BY THE AUTHOR OF "PATTY."

CHAPTER VII.

A MEETING IN THE DALE.

MRS. BARUGH lingered at her gate, looking after Doris, perfectly unconscious of all that was happening down street, as she would have called it; for the High Street, after leaving the market-place, sloped downwards, and passing the cottage, which stood sideways from it, descended somewhat rapidly to the river, out of which came the little beck which flowed through the town. Up street there was coming at a quick pace, which did not seem to suit with his worn face and bent figure, a clergyman. He was scarcely an old man, and yet he was past middle age; he had a thin, red face, which had no pretension to beauty, and his hair was very grey, but there was a look of much sweetness in his faded blue eyes, of refinement in his timid mouth. As he drew near the gate Mrs. Barugh's quick ears heard footsteps, and turning round she faced the clergyman. He raised his hat, and she curtsied, but she made no effort to open the gate.

The clergyman's face flushed, and his lips quivered nervously.

"I — I came to call on your son, madam, and have a chat with him, if you will permit," he said, in so deferential a tone that Dorothy curtsied again, and a pretty little tinge of color made her look almost young. "I noticed on Sunday that he is rather lame, and I hear he is fond of reading. I shall be very glad to offer him the use of my small store of books."

"You're very good, sir, I'm sure."

Dorothy forgot all about her gentility in the outburst of her touched feelings. "Will you walk in, sir, if you please? George 'll be right pleased to see ye. Tho' I'm his mother, and have perhaps no right to praise him, yet, sir, there's few lads like him."

The clergyman stopped and looked earnestly at her.

"I'm sure of it," he said, "he has goodness in his face;" then with a little nervous twitch of his mouth, "I had forgotten — I must introduce myself as the rector of Steersley; my name is Hawnby."

Again Dorothy curtsied, and then she opened the door and announced the rector to George.

The boy's eyes brightened with pleasure as the clergyman shook hands with him and renewed his offer of books.

"It's the greatest kindness you can do him, sir," said Mrs. Barugh, and then she hurried out of the room to fetch the ginger wine and seed-cake, which in her opinion, were the necessary accompaniments of a visit, whether it was paid at eleven o'clock in the morning or at four in the afternoon.

George looked at Mr. Hawnby's sweet, gentle face, and a thrill, the electric consciousness of a long-wanted sympathy, made the boy's heart beat quickly.

"It's great kindness, sir," he said shyly, "but not the greatest. I think coming to see a poor crippled lad's wonderful kind, an' I don't know what to say for 't."

A clatter outside made him look out of window.

"It's t' squire," he said.

The rector left his chair and went to the window; a strange gentlemen on horseback was an event in Steersley.

Mr. Burneston at the gate was looking for some one to hold his horse.

"Mebbe you'll excuse me, sir," said George, and he limped out of the room in search of his mother. "Mother," he called out, "here's Mr. Burneston."

Mrs. Barugh nearly let fall the tray she had just arranged to bring into the sitting-room. She forgot the rector in her surprise.

"Lor', what will John say?" and then came this consoling reflection. John had said she was not to invite Mr. Burneston to call; he had not said she might not see him if he came. Oh, what a misfortune that Doris was out! She straightened her cap and hurried to the gate.

"How d'ye do, Mrs. Barugh?" The squire spoke so frankly and cheerfully, that Dorothy felt she could not deny him anything, let John say what he would. "So you have your daughter back again; is she at home?"

"No, she's not, Mr. Burneston, and I'm rare and vexed; she's gone out for a walk."

"She'll not be long, I suppose," he said carelessly. "I have some business in Steersley, and I'll come back again in ten minutes or so."

Mrs Barugh had been thinking while he spoke, and she answered eagerly,—

"Doris hasn't been gone above a quarter of an hour, Mr. Burneston; she was going to find out Steersdale; she's a famous walker is our Doris."

"Steersdale! why it's ever so far: you shouldn't let her go so far by herself," he said, pettishly. "I'm afraid I can't wait; good day," and raising his hat he rode off.

He was very angry. He had met John Barugh the day before he started for London to fetch Doris, and ever since his craving to see her had gone on increasing at a rate which showed him how strong a hold she had got on his imagination.

"Nothing but idle curiosity," he said to himself; but the curiosity would not be quieted, and this morning he had ridden over to Steersley to satisfy himself by the sight of Doris.

On his way he had tried to prepare himself for disappointment. Miss Phillimore had written him a letter full of praise of her "elegant pupil," as she styled Doris; but she had laid so much stress on the girl's "acquirements, which would do credit to any one," that Mr. Burneston feared he should find her spoiled.

"That schoolmistress has overdone it. If there's anything I hate, it's a clever woman," he said. "Half the charm of a girl lies in her little ignorances, and in the way she has of looking up to a man for information. I sent Doris to school to get polished, not to be turned into a blue-stocking. Learning takes all charm from a woman. I believe, after all, I had better have seen her now and then."

But as he reached the cottage, his eagerness to see the girl had returned, and he could not restrain his anger when he learned her absence.

"What a fool that woman is! Fancy a girl like Doris wandering alone in such a place as Steersdale!"

He only knew the way thither by the highroad, which crossed a bridge over the river, and ended the dale, and he rode off at once in that direction. He had no fear about recognizing Doris.

"If Miss Phillimore is to be trusted, whatever else she is, Doris is a lady," he said to himself, as he left the highroad and entered the dale.

The river was broader here, but still it was evidently much narrower than usual. Gradually the ground rose on each side; on the right the lofty bank was clothed with trees fenced off from the dale by a low grey wooden paling, while beside the river on his left, as Mr. Burneston advanced up the green valley, was a hedge, behind which sloping meadows climbed to the top of a hill, on which a fence of dried furze and twigs stood out in strong relief against the pale green sky.

All at once there came into the picture this vision of a girl springing from bank to bank. He was too far off to see her face, but the grace and freedom of her movements impressed him at once, and he reined up his horse till she had jumped over the last bend of the brook. Then, as her bonnet fell off, something in the slight, erect figure, in the queenly poise of the head, set Mr. Burneston's heart beating quickly, and without pausing an instant, he galloped forward, and sprang

to the ground to greet Doris with all the impetuous eagerness of a boy.

"How do you do, Miss Barugh? I must introduce myself, if you have forgotten me. I called on your mother this afternoon, and she told me where you had gone."

All this time Doris had stood blushing, partly from vexation at her own heedlessness, and now under the squire's admiring gaze. But she made a great effort at composure, and probably her anger at having appeared childish helped her more than she knew.

"I have not forgotten you," she smiled and raised her eyes to his face; "you are Mr. Burneston."

He thought he had never heard words more sweetly spoken, and for the moment he forgot that he had resolved to consider Doris in a calm, dispassionate manner; he forgot everything but the delight of gazing at her exquisite face, and he turned to walk beside her, leading his horse along the dale.

"You have a good memory," he said; then feeling that he must have those eyes once more raised to his own, "Do you find your brother much altered?" he said earnestly.

The long lashes lifted again, and the wonderful blue-grey eyes fixed on his, the pupils dilated with sudden emotion, so that the eyes looked very dark.

"Yes, I find George quite altered, more altered than — than anybody;" then more timidly, as her eyes drooped again, "It was easy to recognize you — you have not changed at all, I think."

He laughed. "Well, I suppose I may consider that satisfactory; you have changed in many ways in these five years."

The bright color flew over her face.

"Yes, I hope so," and there was a stiffness of tone which took him back to the child Doris. They walked on a little while in silence, and then the girl said, —

"Is your son quite well?" As she spoke a flash of angry feeling passed out of her face, and was seen by his ever-watchful eyes. It startled him. Why should she be angry when he spoke of Ralph? She had scarcely seen him, she could not dislike him, and the squire's thoughts went on to a possible future. The solution of her frown was simply self-centred; Doris could hardly keep from calling him "sir" when she spoke, and her anger against herself was vehement.

"Yes, Ralph is quite well, thank you; he is still at Eton, but he will be home at Christmas — at least I am not sure." Mr. Burneston spoke dreamily; it had just occurred to him that Ralph might as well spend Christmas with his aunt and cousins in Scotland. "It is rather dull for him, poor fellow, at Burneston all alone; though he and your brother saw a good deal of one another last holidays."

"I should think he finds George too quiet," said Doris. She spoke easily, seemingly without interest, but also without shyness.

"Well, but" — even as he spoke, it seemed strange to the squire, he almost smiled to find himself treating Doris as an equal, and eager that she should think well of him — "do you think that people should be alike to suit one another? Your brother's silence is just the thing to suit a lively fellow like Ralph, and then your brother is more indulgent than quiet fellows often are, and my boy is a young scapegrace."

"What a pity!" she said simply.

Mr. Burneston felt jarred and yet fascinated. He did not care to hear Ralph blamed, and yet he admired the freshness of nature which could make Doris independent of the fear of giving offence. He walked on in silence.

Doris was glad of the silence; notwithstanding her calm manner, she was inwardly flurried. She had been taken so completely by surprise that she had been obliged to answer hurriedly, and her thoughts never moved very rapidly. She wished Mr. Burneston would leave her, and then she should regain composure. She felt in a nervous and most unusual state under his eyes. "I like to hear him talk," she said, "I always did; but he used to make me feel shy, and it is the same thing now, and it is hateful to feel shy at nineteen."

"Have you been here before?" he said abruptly.

"No. I wish I had come sooner; the country is charming. I should like to stay here for hours."

He looked grave.

"It is too far for your brother, is it? I suppose he is glad to have you as a companion in his walks, when you do not go so far."

"Yes, but he is so lame, he can only go as far as the old castle, or maybe the terrace in the park."

"And you care for longer walks? Well, then, do you know I think Mr. Barugh or your mother should come with you? This is a lonely place without a companion — too lonely, I think, for a young girl to walk in."

Doris looked quickly at her companion,

and her spirit rose against what seemed to her quite unjust interference.

"Father is gone back to the farm, and mother does not like walking," she said stiffly, "and I have always gone where I like in the country."

Mr. Burneston laughed, and Doris felt completely at fault. She had been so accustomed to rule those around her by a quiet stiffness, or rather coldness, of speech and manner — not natural to her, but used knowingly as a means of government — that this want of heed, or rather submission, surprised her.

She felt a sudden interest in Mr. Burneston; he reminded her of Rica. She had not thought he could do anything so un-matter-of-fact as to laugh at any one openly; but she was not courageous enough to ask him why he laughed.

"I must talk to Mrs. Barugh about it," he said; then, feeling that he was not sure of the mother's authority after such a long separation, "I think you had better not come here again alone," he said; "next time your father comes over he will bring you here, no doubt, if you wish."

Doris had recovered herself. She felt so entirely free of Mr. Burneston's authority, that his assumption of this fatherly part amused her.

"I don't think father minds my going so far alone," she smiled. "I loitered to-day, looking about me, or I might have been home now." Then feeling a sudden resolve to take her own position with Mr. Burneston, "You see," she said, blushing at the words, "I am only a farmer's daughter, and girls like me must go about alone, or they must stay at home."

He felt as if some one had struck him a sudden blow, and he answered impetuously, —

"You make a great mistake. If your father had wished you to adopt the ways and habits of — of an ordinary farmer's daughter, he would not have sent you to Pelican House: that has changed everything. Tell me honestly, Miss Barugh" — his color rose, and his eyes grew very earnest — "what you wish — to return to the companions you had before you went to school, or to associate with educated people?"

"I had no companions before, except Rose Duncombe."

She spoke proudly. It was insupportable to walk beside this man and submit to be questioned and advised on her secret trouble, hitherto unshared with any one. She looked very angry, her cheeks burning with mortification and resentment.

"Ah, no," he smiled, "I forgot you were new-comers; but I am sure Rose Duncombe will not suit you now, and yet you must have friends. Will you let me consider myself one of your friends?" he said gently. "Will you let me advise you?"

"Thank you — you are very kind." She was in such a tumult of feeling that she answered mechanically.

"It is something gained that she did not refuse," he said to himself. "She looks like a tempest. What could make her so angry? With all her simplicity, she is very difficult to get on with. However, shyness alters people, and she is shy with me, of course."

They walked on again in silence to the end of the dale by which Mr. Burneston had entered it. As they reached the high-road he stopped.

"I will say good-bye here. I am not going back through Steersley. Then we are to be friends?" he smiled so genially as he held her hand, that Doris smiled back again with a radiance that glowed in the squire's mental vision all the way back to Burneston, even after he had reached the old manor-house beside the river.

CHAPTER VIII.

ON THE ALERT.

It is a truth which every one may not have realized, although of course, as Truth lives at the bottom of a well, only those whose faith is earnest enough can ever brave the risk of seeing her face to face; but thousands who just peep over the well's edge think they have gone to the bottom, from the persuasion they hold that a glimpse is as good as a full view.

The special view of truth I am now meaning is, that time has not the same apparent duration to all of us, though it acts on all. Days which in crowded cities and among busy workers will seem to fly as they pass, and yet to fly carrying with them work achieved or preconceived purposes accomplished — indeed fulfilled progress of all kinds, empty of nothing but of that wonderful old-world charm of leisure which, like the lichen on ancient stone-work, gives to country life its special idyllic beauty — such days, sweeping by with seeming swiftness, carrying with them rest and health, and so much of life's best energies, how full they seem now they are gone! how long we are in reviewing them! And yet, in the sweet peace of country existence, free from the manifold interruptions of town life, when day after

day only the actual routine of life has to be lived, when there is full time for the minutest duty, and abundant leisure for recreation besides, how slowly such days go by, with a delicious long-drawn-out sweetness that seems a foretaste of heaven! How short they are as we look back, because seemingly we have done nothing in them! We cannot see, without a much closer, more earnest investigation, all they have done for us. Link by link, hour by hour, habits have been forming, affections have been developing into love, dislikes have been strengthening into hatreds, and all has gone on secretly and strongly, because uninterruptedly. There have been few external distractions to weaken or stunt the growth of a passion or a purpose.

So days had gone on to weeks, and Mr. Burneston found that his visits to the Steersley cottage had become a necessity of his existence. He did not think or argue how these visits were to end, but he knew secretly that if he were to follow the bent of his inclination he should ride over to Steersley every day. He had surprised himself by the freedom with which he had first spoken to Doris, and he thought he had been premature. When he saw her again she was far more distant.

Ostensibly his visits were paid to George, but Doris was always present; and poor Mrs. Barugh found herself so left out of the lively conversations that the squire kept up with the young people, that after a time she usually took her work into the other room. Dorothy began to find life dull at Steersley. She had few of her wonted occupations, and she wanted John to tease and scold. There was fresh sickness among the cows at the farm, and he only came over for Sunday, and then he was a visitor, and had to be made much of. It was tantalizing to live so shut up alone. George was always with Doris, and the talk of these two did not amuse Dorothy. Steersley was different to Burneston. There were neighbors here whose acquaintance she would have been proud to make, but the squire's visits held these neighbors aloof.

One day she hinted to Mr. Burneston that Mrs. Selby, the wife of the Steersley attorney, and Mrs. Cotswold, the wife of Lord Moorside's agent, were pleasant people, and well inclined to be sociable.

"Please don't make any new acquaintances without consulting me, Mrs. Barugh," he said hastily, "I shall be jealous if you do. I shall think my friendship is not enough for you; and you really know nothing about these people; they may be mere gossips."

His word was law to Dorothy. She smiled and bridled in a glow of satisfaction, but in her heart she felt isolated, or, as she said, "moped." Her longing for gentility had been gratified by the squire's notice, but she knew that this very notice had alienated the people of Burneston from her; they were jealous of the favoritism shown to strangers. Poor Dorothy! her "society" was something like the guinea given by Mrs. Primrose to her daughters; and although she had suggested Mrs. Selby and Mrs. Cotswold to the squire, she felt that she should be quite content with Mrs. Gilling at the Black Eagle, or Mrs. Byland, the wife of the carpenter of Steersley, just to be able to open her mouth on what was happening.

Mrs. Byland lived just opposite; and when Dorothy retired from the trio in the drawing-room, as she persisted in calling it, she spent much of her time at the window, looking for a glimpse of her neighbor over the way.

It was delightful to have an elegant-looking and ladylike daughter, who could sing and play and talk as Doris did, but the luxury was robbed of half its importance when it had to be kept solely for home use, and when there was no one to talk it over with.

To-day, while she watched, she became so much absorbed by this thought, and by her own speculations as to the result of the squire's visits, that she did not hear the street door open and shut. She only roused herself to see Mr. Burneston wave his hand as he rode away, and George standing at the gate looking after him.

"My mercy! to think of my so behaving to a visitor, and such a visitor, of all people! Whatever would John say? It 'ud give him a fine peg over me — that it would. I wish that cow 'd just live or die outright, so as I could get a word with John. There's no speakin' to George; he turns up his eyes an' calls me worldly, before he knows what I rightly mean. And, after all, men's wits is not of much account, unless it's all plain sailin'. It's been one o' the mischiefs o' my life, that I've seldom met with a 'cute woman I could talk over things safely with; though I'm not sure of that; sharp women is apt to be like razors — sharper than safe. Why, what on earth! Oh, my mercy! Yes; it's her, and no mistake."

Mrs. Barugh's delicate mouth opens to its widest, and her faded eyes have brightened, and are staring, as if they mean to

spring from their sockets, over the way, to follow the spare active woman who is entering Mrs. Byland's house. If Doris had not been in the next room, Mrs. Barugh must have called out to George, and have asked for his sympathy in her curiosity; but she was not at her ease before Doris. The girl's quiet simplicity seemed to be always rebuking her mother's strain after "genteel ways," and Dorothy had the constant fear that her child thought her vulgar.

"It was Faith Emmett; I'd swear to her; there's not such another looking woman in these parts. What can she want, prowling here, I'd like to know? I wouldn't have Doris know for anything. Sly old toad!"

Mrs. Barugh altered her position, and placed herself behind the white lace curtain, so that she could see without being seen. Her quick wits at once jumped to the right explanation of the housekeeper's presence at Steersley. "She's come to spy after her master; she wants to see where the squire goes, and she'll make some mischief, as sure as a gun," said the anxious mother. "Well, perhaps, after all, it's a mercy that I didn't get neighborly with Mrs. Byland, for"— Dorothy smoothed out the faded lilac gauze cap-strings which hung on each side of her delicate face (in those days, though only old ladies tied their cap-strings under the chin, cap-strings were a necessary part of the head-gear)—"I should have told her everything—just filled her mouth ready for this old spy. I believe John's right; he's always kep me from makin' friends, because he says I tell too much to every one. Well, Mrs. Byland can only tell what she's seen; but she's a rare Paul Pry, always watching at the window, just like a woman without children; they're a rare lazy lot."

She longed intensely to be in the opposite house listening to the talk between Mrs. Byland and her visitor, and yet she felt helpless; she could do nothing. Mrs. Emmett had a right to visit any friend she might have in Steersley, so Dorothy stood watching and fuming behind her muslin screen, with two fingers pressed against her quivering lips.

On the previous day Faith Emmett's nerves had received a severe shock. Ten years ago her cousin Hezekiah Byland, having grown tired of waiting for his elderly cousin, had married a handsome, dark-eyed York girl, though he had been engaged to Faith for eight years; but as she was much older than he was, and had moreover often refused to leave the Hall to become his wife, her fellow-servants held Byland acquitted, and told Faith she ought to let bygones be bygones, and make friends with the young wife.

Faith bore the desertion silently, and as long as her cousin lived in York it was easier to bear it; but when, previous to settling in Steersley, he wrote asking leave to present his Peggy to his much-loved and respected cousin, the smouldering fire blazed up in Faith Emmett's soul.

"The coward!" she said; "the mean lad, to suppose I waste a thought on him or his!"

But this was only an outburst. Faith summoned her dignity, and wrote a courteous invitation to the recreant Hezekiah; and then, dressed in an old velvet gown given by her mistress, she awaited her visitors.

The grandeur of everything and the stately courtesy of Mrs. Emmett's manners, the way in which she seemed to be a part of the old house itself, her sway over the household, and her lofty patronage, quite overpowered Peggy. She blushed and giggled, answered in the wrong place, and finally threw her glass of port wine over Benjamin Hazelgrave's best trousers, which he put on to do honor to the housekeeper's guests.

Hezekiah Byland had never seen his wife behave so awkwardly, and, being proud and slow-witted, he was vexed, and told her to "mind herself," at which the luckless Peggy, being overwrought and frightened, burst into tears, which under the cold, surprised glances of Faith, and her lofty pity, ended in hysterics and a sudden leave-taking.

"A gude riddance, too," Mr. Hazelgrave had said. "Yer cousin sud hev stuck te his fost Missus Emmett. This missus he's getten is nobbut a haveril."

Since this visit Faith had heard nothing of her cousin, but this morning had come a letter from Peggy.

It began by an affectionate invitation to Steersley, and an assurance of cousinly regard. Peggy said that her dear cousin, Mrs. Emmett, had been brought to her remembrance by the sight of Squire Burneston, who was now a constant visitor at Steersley, courting a bonny young lass from London.

The Burneston people had heard from Joseph Sunley, who managed to know everything that happened to his neighbors, that John Barugh had committed the extravagance of sending Doris to a London boarding-school, and that to save expense

— this was Joseph's version — Doris was not to come home for holidays. "Penny wahse an' pund feealish," Joseph said, and went on to argue that the lass would have been better and happier had she been sent to school with Rose Duncombe.

Faith Emmett had taken little heed of this gossip till one day the sexton said in her hearing that the squire made fools of the Barughs by the notice he bestowed on them. The housekeeper despised Dorothy, who had always scrupulously avoided her, and her contempt deepened when she learned her master's favoritism.

The sudden departure of the Barughs had made, of course, food for fresh gossip, but Faith did not trouble about this, except to rejoice at their absence.

Peggy's letter struck her to the heart; for a moment she was capable of murdering the "bonny young lass" who had dared to attract the squire, and then she laughed at herself.

"'Tis a trick o' Peggy to fright me, bud I'se nut sik a feeal as she thinks. I'se bund t' Steersley the day, an' I'll see wiv me e'en what she me-ans."

She had not heard of Doris's return. Even if she had heard of it, so wild an idea as the truth would not have presented itself; but she went into the village and asked Ephraim Crewe to drive her over next day to Steersley.

Peggy Byland had expected this result. For some time past, she had been burning to show the arrangements of her smart house to some of her husband's people, by whom she considered herself snubbed. She had lost her shyness, and had gained much in self-importance, since she had lived in Steersley, where her handsome face and showy dress attracted far more notice than they had done at York, where she had lived in an out-of-the-way corner, "quite wasted," as she said. Therefore when she wrote to her husband's cousin, the wish to teaze her was mingled with the hope of provoking her to visit Steersley. When the knock came at the door Peggy was sitting in her smart parlor in her best black silk gown and the gold chain she had made Hezekiah buy for her, so that she might look, as she said, like a lady.

The maid showed in the visitor, and then Peggy rose, her great black eyes sparkling under their thick straight brows, and her color brighter than ever, as she went forward with outstretched hands to greet Mrs. Emmett.

"Now this is real kind on ye, ah's zeear is it. Ah hopes ye'se not tired by coomin' oot so far fra home, Missus Emmett?"

But even while she tried to speak as boisterously as possible to show her perfect independence, Peggy's heart sank under the cold scrutinizing glances of Faith's yellow eyes — glances all the more stabbing from the covert way in which they shot from under their long dark lashes.

Faith took the chair set for her with cold self-possession. She did not even ask for Hezekiah; she was resolved that Mrs. Byland should understand that her visit was due only to the importance which she, the housekeeper of Burneston, attached to reports affecting the credit of the Hall.

"What did ye me-an by sending sikan a feeal's tale to me, Peggy Byland?" she said sternly; "writing a post letter, an' mebbe it hev been opened? I'se sham'd on ye."

Peggy's carmine cheeks grew purple.

"Don't ye mak no mistaks, Missus Emmett; there's mair mistaks than haystaks i' t' warld. Ah spose t' squire, as ye calls him, has a right to pleese hissel, and t' lass has a bonny face o' her ain. Ah believe she's leeakin' out in t' windy noo."

Peggy rose, rustling her skirts, and pointed to the cottage.

"Div ye me-an t' say" — Faith's face had grown rigid — "'at Maister Burneston visits at sik a poor owlish place as yon? Mebbe he's gude to 'em — he's rare an' gude, is t' squire. Ye sud mind yer tongue when ye speak agin t' quality, Peggy. Coortin', ye said! coortin', in sik a place as yon! T' ways o' t' quality ain't t' same as fooaks like yersen."

Peggy tossed her head. Faith's provocation had given her the courage she wanted. As she said to her husband afterwards, "Ah wur fair raageous. Ah wern't to be sed by any awd lass."

"Weel, mebbe he kens 'em; but they'se not poor. An' when ah sent t' letter ah didn't spose ye kenned 'em; but Hezekiah said t' mornin' they'se Burneston fooak, an' t' name's Barugh."

She kept her eyes on the window, in the hope that Doris and her brother would come out, as they often did, for a walk. She did not see the change in her visitor's face. Faith turned suddenly pale, her yellow eyes dilated till she looked like a cat ready to spring; but even then she was watchful over her words. The strange part of this woman was, that her outbursts were deliberate, and calculated to produce a certain effect, while her real impulses were as strongly controlled as they were violent.

"They'se not awd Burneston folk," she said coolly; "new-comers — t' farmer, an' t' missus, an' a lame lad?"

She gave a quick, interrogative look at Peggy, who nodded, and then spoke eagerly, —

"Eh, there's more nor t' fayther, an' t' muther, an' t' lad. They come first, an' mebbe two weeks after comes a lass, an' ah sposes she's their lass by the ways on 'em; but she's a lady for a' that."

The withering rage and scorn that possessed Faith are indescribable. She looked at tall, broad-chested Peggy, and felt that she could shake her into fits; but she still kept a seeming calm. Peggy was looking curiously at her. Faith forced herself to smile.

"Mebbe it's Doris, the lass fra scheeal — an' ye ca's her a lady! Fahne feathers maks fahne bods, Peggy. She's nobbut a farmer's lass." She gave a scornful glance at Mrs. Byland's gold chain. "Nae doubt it's t' Lunnon gown; but Doris's nooan a lady, Peggy. They 'at's allays wi' t' quality kens t' differ, where sikan as yersen wadna finnd t'." She ended so loftily that Mrs. Byland's courage forsook her.

"Weel" — she spoke doubtfully — "ah cann't say but yes reeght; but Mr. Burneston hev come tweea tahms sin' Sunday, an we'se at Friday noo."

Faith grew paler, but her face remained still. "How's yer man, Peggy?" she said. "I can't bide wiv ye longer; ye mun just say to Hezekiah I'd bizness in Steersley an' I gied ye a visit."

She refused hospitable Peggy's offers of a meal, and even cake and wine had no power to stay her; she departed professedly to transact her business at Steersley, really to seek Ephraim Crewe and his cart at a farm about half a mile out of the little town.

She did not try to verify Peggy's story; she felt it was true. There had always been something in Mr. Burneston which had eluded her vigilance, and now she felt sure he was disgracing himself. The removal of the Barughs, the long absence of Doris, all sorts of tokens and foreshadowings, dimly seen before, came upon her with sudden vividness. Did Mr. Burneston mean to marry this girl, and set her over the heads of her betters? She felt dizzy as the thought came.

"Gin he'd meant waur he'd not ha' waited while she coomed fra Lunnon," and she trembled with suppressed fury.

But as she sat silently beside Ephraim Crewe, Faith forced her anger into the background, and set herself to see what could be done. Master Ralph had a will of his own, if he could be brought to sustain it; and he was as proud as need be; if he knew the truth, he would not tolerate Doris Barugh in his mother's place.

"There's his cousin," she said doubtfully; but she had not much faith in Gilbert Raine's conventional notions. Mr. Burneston had no other near relative, and Faith knew little about his friends, except the hunting and shooting companions, who came once a year to the old Hall.

No, she must trust to Ralph, and she resolved to write to him; she knew he would not betray her. She should simply tell the boy there was a report that the squire was going to marry a young girl, the daughter of one of his own tenants, and that it might be too late to stop the marriage if he waited to interfere till the Christmas holidays.

Book II. — Courtship.

CHAPTER IX.

GILBERT RAINE IN HIS DEN.

Gilbert Raine was an early riser, and often hard at work in his study before the post came in. In levelling ground on which he meant to build cottages he had come upon some Roman brickwork, and by unremitted digging during the last few days, he and his two gardeners had succeeded in exposing the foundations of part of a Roman house. He was busy writing an account of this discovery for one of the learned societies of which he was a member — so busy, that when the post came in he suffered his letters to lie unopened beside him.

He looked thinner, and, if possible, more eccentric than when he was last at Burneston. His hair hung in dark elf locks over his bright, restless eyes, and the wrinkles on his forehead had deepened, so that when he raised his eyebrows, as he did now, he looked much older than he really was. He wore very little hair on his face; and while he held a letter close to his near-sighted eyes, he pulled at his scanty whiskers with his left hand till his cheeks grew red with pain.

"What on earth ——" Then he turned to the first page and read the letter again.

"My dear Gilbert, — You always said I was to write to you when I was in trouble, and I don't know what can be done about my father. I hear he is going to make a low marriage. Now, you know

I don't want a stepmother at all; they're always a mean, mischief-making lot; even if it was a lady, it would be bad enough. What can my father be thinking of? It seems to me he may be off his head, or some one's taking him in; so will you go down to Burneston and look after him? If you won't, please tell me, and I shall go off post-haste, and get expelled in consequence. But you're such a dear old chap, I know you'll go. We ought, between us, to prevent my father from disgracing the family.

"Your affectionate cousin,
"RALPH AYLMER BURNESTON."

Gilbert Raine left off pulling his whiskers, and grasped his chin tightly, while he once more read Ralph's letter.

"Then I was right, after all," he thought; "and those allusions in Phil's letter pointed to this intention; that's to say" — he crumpled the letter vigorously in his brown, sinewy hand — "if there is a word of truth in this letter of Master Ralph's. I'll bet anything that old housekeeper is at the bottom of it all, and she has set on the boy to get me to interfere. Well, then, shall I interfere? Why should I make myself Faith's tool?"

He stood thinking, screwing up his brown face till it was seamed with wrinkles, while he frowned and closed his eyes. He was so dark, and gaunt, and keen-looking, that, but for the manly, candid expression of the bright eyes, seeing him in this den, with its queer counter-like tables, high stools with black leather seats studded round with brass nails, and walls formed of shelves and pigeon-holes, you might have taken him for an old alchemist or magician.

The tables were laden with books, pamphlets, papers, bits of tiles, etc.; and the mantelshelf was a chaos of ancient fragments — the toe-bone of a mummy, relics from an Indian temple, a stone from one of the lost cities of Central America, a bit of granite from the Menhirs at Erdeven, a Roman statuette from the south of France, coins from the pyramids, with sundry other things — all heaped one on another in a state of dusty confusion, that called loudly for the housemaid and a pair of bellows.

All at once Raine roused from his reverie and walked hastily out of his den, across the black-and-white chess-board floor of the entrance to the dining-hall, a long, bare room, with a dark, polished, uncarpeted floor, six tall windows with small panes set in white window-frames, on the left, and on the right a huge wide chimney with an open hearth, guarded by enormous brass dogs. All round the upper part of the oak-panelled walls were portraits of Gilbert Raine's ancestors, dating as far back as Queen Elizabeth.

It looked very cheerless to see the meagre breakfast — a small coffee-pot, a roll, butter, and an egg — set at the end of a long, narrow table, capable of dining a score of persons, and Raine ate his breakfast in a cheerless, ungenial fashion, walking up and down from end to end of the long room with his mouth full.

Austin's End was a fine old mansion, with a great square oak staircase, up which the wind came rushing on this cheerless September morning to the many galleries and passages up-stairs, and into the large old-fashioned guest-rooms, making the tapestry wave on the walls, till the nymphs and trees thereon depicted seemed to be courtesying in concert to the wounded knight lying outstretched above the scroll-work border. But the bare aspect of the rooms, and galleries, and halls made one shiver even in July. Except the aforesaid tapestry up-stairs, the family portraits in the dining-hall, and a few large blue and white china jars on the staircase, suggestive of rose-leaves strewn therein long ago by fair fingers, there was nothing in the house to relieve the universal dark oak and whitewash. There were treasures in the shape of antiques and curios, locked up in old oak cabinets and chests about the house, but Raine had never yet found time to arrange these stores, he was always seeking fresh discoveries, without an idea of digesting those in his possession.

Before he had been a quarter of an hour in the dining-hall he rang the bell.

"Tell Buxton I'm going to Burneston," he said. Then he went up to his gaunt, comfortless bedroom, with its bare, uneven floor, and packed his own bag.

"Whether it is Faith's mischief or not," he thought, "I must stand by Phil. He's the best friend I've ever had, and I am the only creature in the world he'll take advice from."

But more than once, as he journeyed northward, he remembered that his cousin had taken no notice of the remonstrances he had written from Bornholm, and he sighed as he remembered how very obstinate Philip Burneston could be.

So many years ago it was a two days' journey from Austin's End to Burneston, and Raine did not reach the hall till the next afternoon. "I must be very careful

in what I say." This was his final resolution, as he drove slowly over from the railway station at Wolden, some fifteen miles distant from Burneston.

What a time it was since he had seen the old place! He began to reproach himself for his long neglect, and the seemingly important matters which had kept him at home dwindled into trivialities in memory before the idea that if he had not left his cousin so much to himself, Burneston might not have got into this entanglement.

Faith was in the hall as he arrived. She made a deep courtesy, while Mr. Raine asked Benjamin for his cousin.

"T' maister's gaan ridin' alane, sir. Mebbe he's nut far off."

"Ah! I'll go and look for him presently. How d'ye do, Mrs. Emmett? Have you heard from Master Ralph lately? You'll be having him back at Christmas."

He glanced sharply at the yellow eyes, but they looked perfectly unconscious of mystery.

"Yes, sir, we hope so," and then she added a few words about his room, and Benjamin conducted him to the dining-room.

Raine thought he was glad his cousin was out. The strong dislike to interference which had come upon him as he read Ralph's letter returned with yet more power, and he asked himself what right he had to speak to Philip Burneston on such a special matter unless he consulted him. Benjamin stood behind his chair wondering at Mr. Raine's silence, for Gilbert always had a joke or a kind word for the old servants, some of whom had known him all his life.

"Do you know which room I'm to have?" he said at last, and Benjamin summoned Mrs. Emmett.

"Yey'll like yur aohn room, sir, beturist," she said quietly; "it's awlus fettled, an' it's bin waitin' longer than usual."

She turned to lead the way up the old dark staircase, and, pausing on the first landing, went up three shallow steps into a gallery on the left, and threw open the door of a small room with an oriel window, in which were two easy-chairs and a writing-table strewn with papers.

"It's fair as ye left it, sir, we'se remmoned nought. Master Ralph hev said 'at t' papers waaz nut to be stirred."

Gilbert Raine sighed as he looked round. There was something very comfortable and pleasant-looking in the square Indian carpet and the pale blue and drab hangings; the books and pictures, too, seemed like old companions, and the newly-lighted logs were sputtering and sparkling noisily in the wide grate.

A moment's vision of Austin's End with all these beautifying comforts, and with some one to direct and order all, and take domestic cares from his mind, and then he shrugged his shoulders and screwed up his eyes.

"No, no, let well alone. At least, I have freedom, especially from heartache; and women have a knack of causing that."

He whistled and stooped over his bag, which he never allowed any one to unpack. No one seeing the boyish glee with which Gilbert Raine enjoyed trifles, and his careless way of looking at life, would have guessed how deeply a woman had once made his heart ache. It had happened in his youth; he was twenty-two and the girl was twenty-five. She was engaged to a man in India, but she thought herself free to listen to the clever talk of the young Oxford man, and receive his admiration. He was only a boy, she said, and he was the only congenial companion she could find among the guests in a large country house. So she rode with him and let him repeat poetry to her on long delicious summer evenings beside the river that ran through the grounds; and one evening she was quite taken by surprise when the poor unconscious fellow asked her, with passion in his eyes and voice, if she could ever love him.

"Oh! why did he do this?" she asked. "She was so happy in his friendship, and she had meant to keep him for a friend always." But Gilbert was desperately in earnest. He would not be put off so; and she had to humble herself and avow her engagement, and then endure the lad's scornful reproaches.

Poor fellow! he could leave her in anger, but the effort nearly broke his heart — it made a man of him, and also a woman-hater; for since he had come into his uncle's property many a mother and daughter had tried in vain to make Gilbert Raine take a wife. But that first impression, so sweet and then so bitter, could not be obliterated; he had never seen any one so charming as that girl; and if she could be false, who could be true?

He soon went out in search of his cousin, and meeting Jock, Mr. Burneston's collie, in the hall, he took him with him; but, though they made a long circuit, they could not find the master. All at once, as they paused on the hilltop beside the church, the dog pricked up his ears and went forward, barking joyously. In a

few minutes Mr. Burneston had ridden up to his cousin.

"Why, Gilbert, old fellow, this is capital. I thought it was you, and yet I couldn't believe it."

But after the greeting was over, Mr. Raine thought Philip was unusually silent. He began to hope that after all he might not have to begin this difficult subject. Burneston had always come to him spontaneously with his troubles, and he looked troubled now.

As they passed the two cottages, Joseph came to the door and gave Raine a hearty welcome, but the squire went on scarcely turning his head.

"Well," Gilbert said as the silence continued, "what has been happening in Burneston, Phil? Have you burned Dame Wrigley yet, or has she given up riding on a broomstick?"

"It's curious you should ask that today. The poor old wretch has been left in peace since young George Barugh took her under his protection." An inquisitive look came into Raine's keen eyes as the squire flinched at the name. "But now there is fresh sickness among the cows, and old Sunley is more violent than ever; I am afraid he would like to see Patience worried to death."

"Bloodthirsty old wretch; and he'll see it done, too, Phil. He looked as tough as an ash stick when we passed him just now. Why don't you get the woman away?"

"She won't go."

"Can't you get the young fellow you spoke of, George Barugh, to influence her?"

"I never thought of it, and he's not in Burneston now; he's away with his people." He rode on, getting out of the range of those observant eyes.

"Gone, are they? They were the people on the hill, I think. Have you a new tenant then at Church Farm?"

Gilbert Raine's long legs had soon brought him beside his cousin again, and the downward road through the village was so steep that the horse went slowly.

"I didn't say they had left the farm." Burneston spoke irritably. "I wish they had." This was muttered to himself. "Mrs. Barugh has taken George to Steersley for a time for — for change of air."

"I forget — is he the only child? I don't seem to know anything about these Barughs."

Mr. Burneston twitched his bridle, and then spoke angrily to his horse. He had a vexed consciousness that his cousin, instead of playing with the collie or speaking to the children crowding to the cottage doors, was observing him closely.

"There are two children, a boy and a girl." And then without any intention, except that of changing the subject, "Have you heard lately from Ralph?" he said.

Raine was, as he said, a blunderer. He had no idea of introducing a subject adroitly. In his anxiety to have done with restraint, he forgot his cautious resolutions; it seemed to him that he had better speak, and here was the opening he needed.

They had reached the bottom of the village, and turned to the right beside the river, over which lay a brooding mist.

"Yes, I heard from him this morning." He stopped, but Mr. Burneston did not help him with a question. His cousin's uneasy manner had warned him that something had to be told. "The truth is," Raine went on hurriedly, "his letter brought me here."

"Really! Anything very important the matter?" very drily spoken.

How strange it is that when we are vexed with those we understand best, we often take the worst possible method of making them do what we wish! Philip Burneston wished to silence his cousin, and he showed his displeasure to that end, while he knew, or might have known by experience, that opposition was sure to rouse Gilbert Raine's determination.

A bright flush rose on the dark wrinkled face, and a slight frown deepened the creases round the eyes and mouth.

"Yes, Phil; the boy is anxious about you. It's no use beating about the bush; the truth is, some one has told him you are going to be married."

Mr. Burneston laughed, but he spoke fretfully.

"People are very clever. I certainly have not promised to marry any one."

Raine gave a sigh of relief. "Thank God!" he said, gravely. "I thought it was possibly gossip. The story was, that you were going to marry some girl — well, out of your own position."

Burneston rode on in silence till they reached the great gates which shut in the stable yard and the entrance.

"Wait till we get in, Gilbert," he said. "I should have told you sooner or later, so I may as well get it over."

CHAPTER X.

LOVE IS LORD OF ALL.

MRS. BARUGH felt ill-used and irritable. She had, as she expressed it, been "led a life" by her husband and her son.

When John Barugh returned to Steersley and heard of the squire's visits, he broke out in stubborn anger. It required Dorothy's utmost care and tact to prevent him from showing his displeasure before Doris.

At last the storm quieted; and when he understood that the meeting in Steersdale had been accidental, and that Mr. Burneston always came over to Steersley, as Dorothy asserted, on business, he softened, and was obliged to confess that it was but natural the squire should call in when he was there to see George, as he had done at the Church Farm.

"Dhu mun keep t' lass fra seein' him ivvery tahme he cooms," said simple John.

As he was starting to go back to Burneston he said that Rose Duncombe was anxious to see Doris, and that he had given her leave to come.

"Oh no, John, don't say so. Doris can't abide Rose, they never suited; it'll be a sad mistake for her to come."

But John was in a hurry.

"Bon it," he said, "waat harm can t' lass deea? Bud settle it amang yersels," and he went.

Dorothy gave a sigh of relief. She respected her husband and loved him after her fashion, but just now she did not want him; she was free for a week, perhaps for a fortnight, from his supervision; and she went back into the little sitting-room with a smile on her face.

But at the sight of George standing in the middle of the room, looking taller than usual, and pale with anger, she stopped in dismay, and gave a little cry of fear.

"Why, lad, why, what is it? Are ye ill? What's got ye to look so at your mother?"

"Whist, mother! don't be a silly, an' steek till t' door." Then, recollecting himself, he pointed to a seat, and tried to control his passionate anger. "Mother!" the tears springing in poor Dorothy's eyes softened his rebuke more than she knew. "Yur talk fair caps me; is there no such a thing as t' right an' t' wrang, or are we to make what Doris likes an' dislikes our rule i' life?"

But Dorothy had begun to cry. George had never before rebuked her so sternly.

"I can't bear it, I can't," she sobbed. I do all I can to please the lot of you, and it's one twitting here, and t'other scolding there, and now you lecturing, George, about nothing; it's too hard; so there."

George's mouth twitched. He shrank from giving his mother pain, but he could not shrink from what seemed to him positive duty.

"I'm sorry to grieve ye, mother." He stood before her as if he were the offender; but he went on firmly. "But it's for Rose I speak. Rose was good an' kind to me when I was nobbut a poor helpless sufferer, an' are we to gi' her t' cold shouther now? More than that, Doris an' Rose waazn't friens when they was little lasses; but mebbe tane's as much changed as t' ither now."

Dorothy tossed her head.

"Never, lad, never; can't ye feel a difference as well as see it? Rose is——"

"Stop, mother; deenut say what I cannut listen to. Rose is my friend, and I waenut hearken to a word o' blame about her from you or any other. If she an' Doris deenut fancy yananidur, let 'em keep apart. But it's hard on Rose an' me, an' I say, gi' 'em the chance. An', mother," he said earnestly, "for my sake ye'll be kind to t' lass whenivver she cooms."

And Mrs. Barugh felt how much harder it was to resist the sway of her quiet invalid son than of her more irascible husband. John was patient; but when his anger was roused it was tremendous, and defeated its object.

"'Tis the worst of being so good, lad," Dorothy said as her son kissed her. "You're so often right that you can never think ye're wrong. Well, I s'pose I must take the long wi' the short, and let ye have your will; but don't say a word to Doris."

Her earnest hope was that, as she knew Rose had other friends in Steersley, the girl's visit would be short, and would happen during Doris's frequent walks.

For Doris, who had become very lively and companionable, had lately gone back to the silent abstracted moods of her childhood. Mrs. Barugh noted this, and drew her own conclusions; but George was puzzled and disappointed.

He had been growing stronger every day, and he often walked with Doris; but she was more dreamy and listless alone with him than in her mother's presence.

To-day, as they sauntered on the velvet turf within the grey ruins of Steersley Castle, he said suddenly, "What ails ye, lass; is it love?"

"George!" She blushed and looked annoyed, and then, recovering herself, she laughed. "Oh, George, what nonsense! Don't you remember I was often like this?

My friend Rica Masham said she had cured me; but I don't know. I wish you could see Rica, George; it would be nice for you to have a friend like her."

George flushed, but Doris's eyes were on the grass at her feet. "I has you an' Rose," he said with an effort — for he rarely spoke of Rose to his sister. "I think a lad has enough wiv two of ye."

Doris raised her head, and her lips curved in a slight smile.

"But I can't help thinking if you knew Rica you would like her best of all; she's so bright, so joyous, so full of mischief, she makes one feel so young."

George forgot his vexation. His brown eyes twinkled merrily.

"Young — that gude for ye, lass. Mebbe ye'll be wanting a cap soon like mother's. Make hay while t' sun shines; ye'll never be younger than ye are now."

"I'm getting old; I really am getting old, George," she said; "I'm nearly twenty."

But after this she roused, and talked of Rica and her school-life till they reached the cottage.

"Please, miss, there's a visitor."

Doris's heart beat with she scarcely knew what anticipation; but George went on eagerly, opened the parlor door, and saw, as he expected, Rose Duncombe seated beside his mother.

Rose jumped up eagerly, shaking out her skirt with excitement, and rustling in the consciousness of a new, stiffly-lined gown and a showy scarlet shawl.

George's smile of glad welcome was slightly subdued as he watched the two girls shake hands. Rose was much prettier than Doris, he thought; her eyes were so sweet, her hair so bright and golden, and her color as fresh as a rose. But, although he thought his sister's dress too staid and quiet for a girl, it seemed as if Rose was a parroquet beside her. The village girl flamed with blue and pink and scarlet, and her hearty laugh and boisterous greeting jarred on him as it had never done before. But this feeling was only transient; he saw that Rose grew shy, and that Doris was stiff, almost haughty, and in a moment his allegiance came back.

"My word, you hev grown tall!" Rose tried to cover the awe she felt of Doris by a familiar manner which sounded pert. Doris was even more disgusted than she had expected to be, for she had not counted on Rose's assumption of equality. She thought school would have made the girl affected and silly; but this off-hand freedom took her by surprise, and made her own manner constrained.

"I suppose my nose is out o' joint wi' you, lad," Rose laughed at George, "now 'at ye've set up a real sister. D'ye find him changed, Doris? My word, yey've changed yurself; I wouldn't hev known yey!"

"You are not much altered," said Doris in a polite, cold voice. She was angry with herself for being so irritated; but every word the smart, rosy-cheeked damsel said took her back years — to the farm kitchen and to herself, in her lilac pinafore and sun-bonnet. She felt that she hated Rose Duncombe.

"Not much altered!" Rose was violently mortified. "That's what *you* think, is it?" she turned to Dorothy with flushing cheeks. "She's not changed in some ways, Mrs. Barugh. She's just as short-spoken as ivver, I see, an' she cocks up her chin as like——" Doris gave a slight shiver of disapprobation, and George looked troubled. "But nivver fash yourself, Doris; I'll take myself off. I don't need to force my company where it's not wanted; there's plenty only too glad on it." She turned her back on Doris, her eyes sparkling and her face hectic with passion. "Never you mind, lad; I'll come an' see yey when yey gits back to t' farm; she'll" — jerking her head towards Doris — "hev settled down by then. Good-bye, lad; I've a heap of friends to go an' see in Steersley, though I began wi' you. Good-day."

All this was spoken in breathless haste, while the listeners were dumb with surprise; and, squeezing George's hand, and nodding to Mrs. Barugh, Rose ran away without taking any leave of Doris.

"Oh, Doris! What have you done?" George spoke at once and angrily, for he had seen tears in Rose's bright eyes.

"Done!" — Doris drew herself up with dignity — "I really do not understand. I do not wish to vex you, George, but Rose Duncombe seems to me a very ill-behaved young woman. She certainly has not changed for the better."

"It's easy for those 'at haven't got strong feelins to keep cool and quiet. You know nothing about feeling, Doris; all you think of is manner. How would you like to be snubbed by one of your equals? and Rose Duncombe" — he looked at her sternly — "is much more your equal than Mr. Burneston."

"Ah, my lad, don't" — Mrs. Barugh placed herself between the brother and sister, for George's vehemence frightened

her, she could not understand it — "why should you bring the squire's name up at all? What can he have to do with Rose?"

Doris walked away to the other end of the room. She did not give a thought to George's wounded feelings; she only felt that this kind of rude quarrel was wholly ruffling and unsettling; during all the five years she had spent at Pelican House she had never been so much moved out of her habitual self-control.

"It all comes from their want of breeding," the poor girl thought; "and what will become of me? Shall I sink to this, to quarrel and be rude, like Rose, and grow altogether coarsened?"

But George was speaking in a steady, determined voice, that compelled her to listen. "Mother," he said, "mebbe you didnut take notice; but it was varra hard. The girl have comed over here with a heart full of affection to welcome an old friend, an' t' old friend treats her like a strangei. I'm sorry I spoke so sharp, Doris. Mebbe you didnut mean no harm; mebbe them's London manners. If they is, I says I likes t' old ways best. But I'se grieved for Rose; she's vexed with hersel', poor lass. She wur fair set on Doris."

Doris looked very grave.

"I'm sorry too, George, but you know I never was Rose's friend, and I do not think I should get on with such a hasty person. Pray do not let us talk about her."

"No, my dear," Mrs. Barugh spoke soothingly, "it is not to be supposed you would get on with poor Rose. She's a kind, good-hearted girl as ever lived, and she's been an amusement to George when I couldn't be with him; but she's had none of your advantages, of course, and George won't think so much of her now he has you."

"Mother," George blushed like a girl, "dinnut find fault with Rose, I cannut bid'un. Mebbe she's wanting in many ways. She's old-fashioned an' countrified. Well, so's I, but she hev got a heart, and she hev nivver said an unkind word since I knawed her, an' I'm not going to gi' her up to please Doris."

"You are unjust, George, I do not ask you to give up Rose." Doris spoke calmly, but she looked pained. In her heart she was shocked at her brother's persistence.

"Why should I?" he said sternly. "She braids o' us; she's o' t' class we waaz born in, Doris. Eh, deeant yey go for to cheat yoursel', lass, yur friend Rica, as yey calls her, 'll cock up her neb at yey when she sees what sort yey are, an' as for t' squire, he just cooms t' see us as his tenants."

"You're out there, my dear." Mrs. Barugh bridled and looked as nearly angry as she could be with her beloved son. "We're not Mr. Burneston's tenants here: it's one thing for him to come and see us at Church Farm, lad, quite another for him to come here: it's plain he looks on us as friends."

"I nivver meant he didnut think us friends, mother, what I means is equals. D'ye think, mother, t' squire wad bring a friend to see ye or ask ye to t' Hall nobbut to see Mrs. Emmett, an' I fancys Doris wad be as ill pleased wi' Missus Emmett as wi' Rose Duncombe."

"George" — Doris came back and stood beside him — "don't let us talk about this. We can't see things from the same point of view; only I think you ought to remember that I never did like Rose."

"An' ah says," George spoke earnestly, "yur wrang. Yey've changed by yur learnin', an' so hev t' ither lass, an' yey just sits in judgment on her wivout gi'in' her a chance o' pleasin' yey. But nivver fear, ah deeant want to force Rose on yey, Doris; she an' ah's coompany for ane anither; bud maand off! Ah wonnut hear a word agin t' lass fra yan o' yey."

He limped out of the room. He was himself troubled by his own agitation, which he found quite beyond control (in speaking he had returned to the words of his childhood), and he wanted to prevent further strife.

Directly the door closed, Mrs. Barugh broke out in lamentation.

"Oh dear, oh dear, this world's a trial, and George and me have never had a word in our lives before. I wish you could have seemed more friendly to the lass, Doris, just for George's sake. You see he looks on her as his friend, and so he takes it to himself."

Doris made no answer. She was walking up and down the room, her fair forehead puckered by a frown and her delicate lips firmly pressed together.

"Don't you see what it is, mother?" — she stopped short in her walk and looked reprovingly at Dorothy.

"No, my dear. What d'ye mean? I ——"

"Well, then, mother, I think you ought to have seen, for this cannot have come all at once. At least" — her cheeks flushed a little — "I fancy not. George loves Rose Duncombe." Mrs. Barugh turned so pale that Doris spoke more gently.

"I'm sure of it. He would not excite himself in that way if he did not feel very strongly, and, besides, he has said other things." She was thinking of what he had said in the park that morning.

"Oh, Doris, I can't think it. How could a poor lame lad like George take a wife? He'd have nothing to live on, and we'd be forced to have her to live with us. Oh, George, lad, no wife'll ever love ye as your mother does."

She sat down crying, and smothered her face in her handkerchief. It was the most miserable moment she had ever known. George, her own George, to whom at least she thought she was all in all, had given his love to Rose, and here was Doris, her own child too, and yet so much a stranger to her family that she was not grieving at the loss of her brother's love, but only angry that he had given it so unworthily.

"Mother" — Doris spoke in the proud, resolute tone that had so awed some of her schoolfellows at Pelican House — "you must leave off crying, and you must think. George is so young that it's nonsense to take such a thing to heart. It could never have happened if he had lived anywhere else and seen other companions as well as Rose, and I think it is all on his side. I am not sure that she cares for him. She seems too much at her ease."

"Not care for him!" Mrs. Barugh wiped her eyes hastily and sat upright in her wonder. "D'ye mean to tell me, Doris, that such a lass as Rose wouldn't be proud of your brother George's love? Not care for him! Why, who is there in all Burneston, or for that matter in Steersley neither, fit to hold a candle to my lad?"

Doris smiled. "It's not that, mother, but George is too quiet for such a girl as Rose. She's not one who'll care to sit still in-doors. She is vain and silly, I am sure she is, and she has the common sort of nature that would seek to be admired. I can't bear to think George loves her."

"He's seen no one else, that's it," Mrs. Barugh sighed; "but it's too late now, Doris; if it's as you say, it won't do to be finding fault with her; it will only make him worse. You've made me sadder than I ever was before. O George, lad, how can ye take up with a girl like that instead of your mother! She'll never love ye half so dearly. O my lad, my lad!"

She covered her eyes with her hands. Doris stood thinking with a very anxious face.

"Mother," she said at last, "it will be better never to go back to Burneston. Such a girl as that will soon forget George, supposing that you are right; and if she does not love him, will it not be much kinder and wiser to keep George out of her way?"

Mrs. Barugh shook her head miserably.

"You don't know yer father, child. He can't abide changes — the trouble I had to get him to leave Pickerton! And though he's never, as one may say, taken to the Church Farm, still he's begun to lay out money there, and I doubt if he'd be willing to leave before he's got it's value returned."

"But you don't cling to Burneston, mother." She did not wait to be answered. A sudden hope, the outcome of her long reveries — reveries which, beginning in fear, always ended with the certainty of future mortification in life at the Church Farm — made Doris strangely earnest. "I own to you that I shrink from going back there. Yesterday you told me that George's health was so much better away from Burneston. Surely my father will not sacrifice us all for the sake of a few pounds."

Mrs. Barugh looked utterly miserable.

"I'm sure I don't know, Doris. Your father has been at great expense for you, and then there's this cottage and the giving notice. Why, child, a man can't step out of one farm and get into another as easy as he changes his boots."

"I suppose not." Then, while a rush of color flew over her face, making her frown with vexation, "but with Mr. Burneston it might be different, mother." She threw her head back and spoke very coldly. "I don't think Mr. Burneston wants us back at the Church Farm."

CHAPTER XI.

A THANKLESS OFFICE.

MR. BURNESTON was silent until he and his cousin were seated in the library; even then he seemed unwilling to return to the interrupted conversation.

He sat whistling and playing with a paper-cutter, which he had taken off the table.

"Yes," he said at last, "I wish that old Wrigley would go away, it might save mischief."

Gilbert Raine had been feeling more shy and ill at ease than he had ever felt in his life; it was a relief to be able to speak of something else than the subject in his mind.

"Why don't you see about it? But it's new to see you worried, Phil; except now

and then when Ralph was troublesome, or one of the hunters came to grief, you took life so easily."

"And so I shall again, old fellow; just now I can't."

There was silence after this. Raine fidgeted and made a most hideous scraping by moving his chair on the uneven oak floor. At last he told himself he was a coward.

"Phil," he cleared his throat, and there was a comical twinkle in his bright eyes, "when we were little chaps, we used to tell our troubles to one another. I suppose this story I've heard is true then?"

Mr. Burneston rested his elbow on the back of his chair, and shaded his face with his hand.

"True in some ways, but not in saying the — the person in question is my inferior."

"Thank God!" said Raine with energy, and he settled himself for a comfortable talk. "Let's hear all about it, old fellow," he said; the relief was so great that he felt cheerful. "I hoped you would have kept your freedom, but I suppose you can't get on alone."

Mr. Burneston looked uneasy. "I speak as I feel," he said pettishly; "the world, of course, will not agree with me; it remains to be seen, Gilbert, whether you can venture to have an opinion of your own, or whether you are influenced by Mrs. Grundy."

"I think I have shown the contrary." But Raine was troubled by this beginning.

"Well, it's soon said. We were speaking of the Barughs just now. The daughter, Miss Barugh, is very refined, highly educated, and — in short, if she will have me, I mean to marry her."

Raine sat stupefied for an instant; then forgetting all restraint, he said eagerly, —

"Then you've not asked her yet? for God's sake, don't, Phil."

Mr. Burneston got up from his lounging position, and went and stood against the mantelshelf, with his hands behind his back.

"Gilbert," he said quietly, "did you ever know me to give up anything when once I had made up my mind?"

"Perhaps not; but hitherto the question has been about something which did not touch the welfare of your whole future life, and Ralph's also."

"Am I to give up my whole happiness, then, to avoid a possible annoyance to Ralph? Nonsense. Don't you see that in three or four years Ralph will have his own friends and live his own life, without the slightest reference to me? We have scarcely a sympathy in common ——"

Raine sighed.

"Pardon me, Phil; but I must think a good deal of that is your own fault."

A flush was rising in Mr. Burneston's face. "You mean," he spoke quickly, "because I left him. Well, then, I think you are wrong. I was unhinged and restless, and I always have disliked boys. If I had stayed at home, probably the boy would have hated me; now, at least, he cannot feel that I am harsh or stern — in fact, we are very good friends when we meet."

"But do you think he will submit patiently to a step-mother out of the village? Now stop, Phil, I am only speaking from Ralph's point of view. How will constant domestic strife and petty squabbles suit with your fastidious notions of refinement, culture, etc."

"To begin with, if you knew Miss Barugh, you would see that one of her great charms is the absence of all pettiness or feminine frivolity. She has not been brought up in her own home; she is ——" He broke off with an irritable laugh. "I really don't know why I enter into the question; almost every man left as I am marries again, and if I am satisfied, what does it matter? And certainly Miss Barugh wants no defence. She is just the wife I want. I intend to live quietly at Burneston; you know I always disliked London and society; after a bit Ralph will be quite satisfied."

Raine sat musing. It was so impossible to him to believe that Philip Burneston of all men could be hopelessly in love with a farmer's daughter, that he could not bear to give up the matter as settled.

"Don't do it, old fellow," he broke out impetuously; "you'll be so sorry if you do. That sort of polish is like varnish or veneer — it only hides, it cannot eradicate. Now could you bear to have sons and daugters of a different breed to Ralph? Fancy how he'd look down on such brothers and sisters — a row of little farmers."

Mr. Burneston had looked very angry, but he laughed as his cousin ended.

"We have argued this subject once before, when, as you may remember, you put this idea in my head, Gilbert," he said ironically. "I do not mean this as reproach; on the contrary, I am thankful to you, it has given me something to live for. I believe I shall be very happy, though I am prepared for an outcry at starting."

"You think nothing of example then. Suppose a woman in your position married

Joseph Sunley, or a young man of his class, do you think the precedent would be a good one?"

Mr. Burneston looked grave. "No, of course not; nor are the cases parallel; it is absurd to put it in that way. I don't say my own affair is good for others; but I don't set myself up as a pattern. Besides, I am not doing this in a hurry. I have thought it well out. If I see any reason to suppose I am mistaken, I shall not ask Miss Barugh to marry me."

"Then is it quite fair to go on raising expectations which perhaps, after all, won't come to anything?"

"What are you driving at?" Burneston turned round and faced his cousin, and he saw the keen anxiety in Raine's face. "What do you want me to do?" he said more gently.

"Well, as you ask me, I'll tell you. Don't see Miss Barugh for three months or so. Come down with me to Austin's End, or we'll go away abroad somewhere together; and then when you come back you will see with clearer eyes, and will, besides, have had time to think it over calmly and dispassionately."

"And find that some one else with more courage has won her. No, Gilbert." He looked as hard as the mantelpiece behind him.

"I should say there is no fear of that: there are very few men such as you who would dream of marrying Miss Barugh, and with her notions and the education you speak of she would not accept a young farmer. No no, she'll wait for you. My dear Phil, do open your eyes; do you suppose the girl will give up the chance of being mistress of Burneston Hall?"

"She does not dream of such a thing," said Philip angrily; "you don't understand her a bit; how should you? You know nothing about women. Certainly, you never met such a woman as"—he was going to say "Doris," but he checked himself—"Miss Barugh."

Perhaps his voice had taken an angrier tone because he remembered so vividly the child swinging on the gate and her song.

"If she does look forward to it," he thought, "it's only natural; and it is my own fault;" but this excuse did not take away the sting of Raine's accusation.

Gilbert was growing tired of his position.

"Well," he said, "I have done my duty. I came for your sake and Ralph's, and I seem to have done no good. I had better have left it alone." He got up and walked to the window whistling.

Burneston always found it difficult to be long angry with any one. He loved peace so much that he was always willing to make the first advance; and his wife had understood this, and had profited by the knowledge.

"Look here, Gilbert," he said, "of course I get vexed easily about this affair. I don't want to deceive you, it's true I love this girl more than I ever loved any one, but I am not besotted; come over with me to-morrow to Steersley, and judge for yourself. If after seeing her you say she is not fit to be my wife, then—I don't say I'll give the thing up, but I promise to think it over again, to be prudent, and not to pledge myself to any hasty engagement."

"Very well," but Raine spoke unwillingly. He could not see how, by looking at this girl, he was to ascertain her merits.

"I'm too late," he thought, "the mischief's done; what unutterable folly this love is!"

They separated after this; and though they met soon after at dinner, and seemed as friendly as ever, each was conscious that they had grown farther apart than they had ever been before in their lives.

CHAPTER XII.

"OH, HELL, TO CHOOSE LOVE BY ANOTHER'S EYE!"

GILBERT RAINE woke next morning with the consciousness of an unpleasant weight on his spirits, which, like a bad taste in the mouth, took away the flavor of the day before him. But as he threw his window wide open, a keen crisp touch in the air was exhilarating, and the silvered grass and tree-twigs showed there had been a white frost. One of the mercies most carelessly and thanklessly received is that of change of temperature to a worried mind, and as the keen air found its way in freely, an elastic freshness pervaded Gilbert's mind, and went downstairs with him to greet his cousin.

It seemed as if Mr. Burneston had forgotten his annoyance. He was smiling and cheerful as usual, and had a half-conciliatory manner, which puzzled his cousin. He really cared for Gilbert Raine's good opinion, and, more than for that, as has been said, he cared for living in peace. He was resolved not to increase his cousin's prejudice against Doris by showing any vexation, he felt so sure all prejudice must vanish in her presence.

"Shall you be ready to ride this morning?" he said. "I have ordered Punch for you. He used to be a favorite of yours."

"Thank you, old fellow." Raine began to see that his cousin was really anxious to propitiate him; and he felt hopeful for the result of his advice. He was fond of riding Punch, nearly the best horse in the Burneston stables; but he was such a careless rider that he had seldom been offered the chance of mounting him.

He was rather put out by the hurry Mr. Burneston was in. He had discovered one or two old books in the library relating to some work he had in hand, and would have liked an hour's look at them before starting; but he was hurried and bustled, and not left in peace till he found himself riding beside his cousin on the highroad to Steersley.

Mr. Burneston had determined not to take his cousin to the cottage, nor to introduce him to Mrs. Barugh. By this time he had grown acquainted with Doris's habits, and he knew that at the time he counted on reaching Steersley, he should find her taking a walk with George in Lord Moorside's park, or seated reading among the ruins of the old castle of Walter l'Espec. He had more than once found the brother and sister thus occupied, and he thought he should like Raine to see them too, where her surroundings would be in keeping with Doris's perfect beauty. One thing he had not counted on — the absence of George.

Ever since Rose's visit, there had been an unspoken but decided coldness between the brother and sister. George told himself that he was in the right to hold fast by old friends and keep in his own station; beyond this he thought he was teaching Doris a salutary lesson, for he disliked and disapproved the pleasure she seemed to find in Mr. Burneston's visits.

"I likes t' squire," he said to his mother, "he's very kind, an' I'se reet glad to hear him talk and see his kind, cheerful face; but when he's gone, I'se t' same as ivver I was, while Doris sits glum, an' when I speak she gives a start as if I'd stuck a pin in her."

Mrs. Barugh smiled with an apparent mystery that irritated George. "Perhaps Mr. Burneston's talk makes her think," she said. "It's an uncommon advantage for you and her too to get such talks about things with such a gentleman."

"I'se none sure o't," said George. "Mebbe it's pleasant, but it's safer not to get to like things out o' reach, mother. Mebbe Doris 'll end by thinking hersel' t' same as t' squire."

He looked so stern that Dorothy suppressed the first answer that came to her lips.

"My word! ye've taken to lecturing, lad, and it don't suit ye," she said; "go out in the sunshine, 'twill do you good. Go after Doris; she's at the castle, I fancy, for she took a book with her."

George muttered an answer, but he stayed in-doors. Something, he could scarcely tell what, seemed to be creeping into his life. As he sat thinking, he roused to a consciousness first that he was being mastered by Doris, and when he had quenched the stubborn resistance which this thought brought there came another revelation. George had thought himself a sufferer denied the amusements and enjoyments of his fellows, he had pitied himself, but as he looked back grudging his former liberty, it flashed upon him that he had been spoiled into self-will. "I'se selfish, that's what it is, I'se got to cling to mah ways an' mah likings till I'se stubborn at being crossed. What for sud I feel vexed when Doris talks about her friend Rica? The lass means nae harm, an' she's free to love her friend as I love Rose. Nay, I'se wrang, Doris taks likin' cooler than I diz."

George was right. Doris felt that there was a coldness between herself and her brother, but she did not suffer from it. Her thoughts were now always so filled with Mr. Burneston's visits, and the memory of the talks that went on in them, that she had no time to waste on George.

"After all," she thought, as she sat down beneath the castle-wall and looked through the yellow leaves at the village at her feet, "life at Burneston will be pleasant enough if he comes to see us there." Here she stopped with a sigh. Only yesterday Mr. Burneston had again said he hoped they would not be in a hurry to go back, and before that he had told George that it might entirely restore his health if he left Burneston and went to live near the sea. Did he want to get rid of them? It was a puzzle.

"I am growing idle," she went on. "I must remember to ask Mr. Burneston for the books Miss Phillimore recommended me to read. I shall go back if I don't keep up my studies, if I get interested in books I shall feel more settled. I think too much about Mr. Burneston's visits;" but she went on thinking of them.

She liked him very much. By talking chiefly to George he had managed to set

her completely at her ease, and he so carefully restrained any expression of admiration that she had no excuse for suspecting it, and although she often found him looking earnestly at her, she did not suspect it. She delighted in his visits because his refined speech and cultivated ideas were at once a link to the past she prized so highly, and a help against the future she dreaded; but the tumult of excited feeling and gratified vanity aroused by the meeting beside the brook had soon subsided. She thought of Mr. Burneston now as a valued, middle-aged friend; it would not have occurred to her to think of him as a lover, he was so much older than she was; and, besides, Doris had taught herself long ago that she could never marry, now that education had taught her to shrink from her equals. It would be the price she had to pay for the advantages she had had, but she knew nothing of love, and she did not look on it as a sacrifice.

She had not heard any footsteps, but the click of the gate of the little green plot in which she sat made her look up, and she saw Mr. Burneston and his friend.

"Good morning, Miss Barugh." And then Mr. Burneston presented as his cousin the tall, dark gentleman, whose keen, searching glance made the color rise on Doris's cheeks. "Is your brother ill?" the squire asked, for he saw an amused smile on Gilbert's lips.

"No; but he does not always come with me — at least, not lately." Doris spoke stiffly; she had a consciousness of being silently observed.

"I thought he did; perhaps the hill tries him." And then Mr. Burneston stopped; he could not think of anything more to say.

"Do you sketch?" Raine said. "There is plenty of subject here, I fancy; and this is a very good point."

"No; I don't draw at all." Doris raised her eyes and looked gravely at Mr. Raine, and then she looked away. It was intolerable that he should keep those bright, keen, black eyes fixed on her face. She wondered that Mr. Burneston's friend should be so rude.

"That's a pity; it's a great resource in the country. Ah!" he went on, "perhaps you're fond of reading?"

"Very." But Doris looked still graver.

"Novels and tales, I suppose, with plenty of romance, and so on."

"I have read very few novels. I like history."

Gilbert was provoked. "Ah, you have solid taste, I see. Do you like the country?" he said flippantly.

Doris smiled, and the radiance in her face thrilled through her questioner. "She's beautiful!" he said to himself. "I can't deny that."

"Yes," she answered. "At least I like Steersley, and I don't like Burneston; those are the only country places I know."

"You don't like Burneston, don't you? Why, what's amiss with it?"

His familiar tone amused Doris. It reminded her of Rica, but it wounded Mr. Burneston. It seemed to him that Gilbert had been catechizing Doris like a child, and that he talked to her as if she were an ordinary farmer's daughter.

"Miss Barugh is right; there is not much to see in Burneston."

"I did not like it when I was a child," said Doris.

"Why not?" Raine asked eagerly.

Doris was puzzled by his questioning; she did not care to give her reasons to this inquisitive man.

"I think because I had no playfellows, and because there was no sea there. We came to Burneston from near the sea."

"Perhaps you would like it now."

Raine spoke mischievously; he really wanted to provoke Doris out of what he thought an assumption of sedateness. Mr. Burneston could hardly keep in his impatience.

"No, I don't think I should," said Doris, calmly. She looked at the squire, wondering at his silence; and it seemed to him that she appealed against Gilbert's impertinence.

"Well," he said, "we are keeping you from your book. Good morning, Miss Barugh; perhaps we shall find your brother as we go through the market-place."

Raine made a profound bow, and was taken aback by the grace and self-possession with which Doris returned it; he had not succeeded in making her feel shy; she was a little annoyed by his rudeness, but his originality amused her; he felt foiled and vexed with himself, and was not in a patient humor.

Mr. Burneston did not speak till they found their horses again at the lodge gates.

"Well?" he said, as they rode out of Steersley.

"She's a very fair creature," said Gilbert Raine heartily. "I must own that much."

"Her beauty is the least of her attractions, but of course you gave yourself no opportunity of judging."

"You're wrong there; I proved her

temper and her temperament; she's as cold as a bit of granite, and as proud as Lucifer."

"Any girl would have been irritated by your manner."

"Not if she were thoroughbred. This one has all her horns out, and suspects mischief where none is meant. It won't do, Phil; she's too raw and untrained for you, my boy, if you want to keep a quiet house."

"What do you mean? I consider her manner quite charming." Burneston spoke in a huff.

"Well, then, shall I tell you something else, usually a consideration in matters of this kind? She doesn't care two straws for you. If you ask her, and she says 'Yes,' it's because she means to be mistress of Burneston."

Mr. Burneston turned half round on his saddle, with a very set look on his face.

"Look here, Gilbert; you know how I hate quarrels; don't say anything more, or I may say more than you like; Miss Barugh behaved as well as possible; my mind's made up, and you only waste words." Presently he said cheerfully, "Come, come, old fellow, you had better make up your mind to be my best man at the wedding."

Raine felt very angry. He considered all women inferior beings, not fit to be trusted; and it seemed to him that this one, a mere farmer's daughter too, had placed herself on an equality with him. She would be hateful as mistress of Burneston. It was a selfish way of looking at the matter, but he could not help it.

"No; I can't be that, Phil," he said earnestly, "and I must be consistent. I can't bear to think of that girl as your boy's stepmother. Don't let us quarrel." Mr. Burneston was frowning in a most unusual manner. "I must just say this, for the sake of old times, don't do anything in a hurry. No good can come of an unequal match — only divisions and heartburnings; and I fear, in this case, sorrow and disappointment to you."

CHAPTER XIII.

A PROPOSAL.

It seemed as if the return of Doris had been trying to the temper of all her friends. Rose came home with a face swelled with crying; and when at last she succeeded in making Mrs. Duncombe hear her grievances, the deaf grandmother gathered that Doris was a "set-up dowdy, wi' not so much as a flower to her bonnet," and "as sour as a apple in May," with other disparaging comments, all of which were duly enjoyed by Mr. Sunley as he sat smoking at his cottage door. The evening was chilly, and he had "happed" an old worsted comforter round his neck. He would have preferred the enjoyment of a pipe beside his own snug little fireplace, but so rare an event as Rose's return from a day's pleasuring was not to be disregarded; and there he sat listening with all his might, nodding and making comments on the passionate sentences which the girl jerked out in the intervals of taking off her bonnet and shawl, rolling up the strings of the one, and flattening out the creases of the other with her plump pink hand. His face grew more and more content as he listened.

"Eh, eh. It's t' way wiv yaal t' lasses: ane cannt abide t' idur gin sheea's bonnier," he said. "John Barugh's lass war a bonny lahtle lass, an' mebbe shee's mitch bonnier noo. Sheea mun be, else Rose wadna sharpen her tongue agin her. Poor Rose! sheea's as sharp as a briar, bud sheea's a feealish lass! Skeal ain't takken that oot o' her."

John Barugh had been extra reserved when his old neighbor had asked after Doris. He had indeed been thoroughly unsociable, spending much of his time with his sick cows, and brooding so over the question of their bewitchment, that he had little time or thought to spend on Doris, except when he went to the Steersley cottage. A vague feeling of uneasiness crept over him when he remembered Mr. Burneston's visit, but he did not care to revive his disagreement with Dorothy, and had not recurred to the subject. He was therefore entirely ignorant of the frequency of the squire's visits, or of the notice they were attracting.

"T' squire hev'nt been tuh t' farm sin t' missus an' t' sick lad gaanged tu Steersley," Joseph said, quite unconscious that if there had been any one near his words were audible. "Ah cud nivver tell 'at he cud finnd i' t' tawk o' t' missus. It fair capt mah. Ah thowt John wad hev been mair neeghberly wivout her, bud isted he's as glum as a dour-neel. Eh, maister, how's a' wi' ye?" he shouted as the tall red-bearded man came in sight within the white gate of the pig-yard.

"T' coo's deein'." John spoke sullenly, and there was a lowering, gloomy look in his eyes, as he opened the gate and came across the road.

"Eh, neeghber, yey deean't say sae. Tell yey waat t' is, lad, yey mun draw bluid

fra t' witch, an' draw it sune. Ah's staggonated at sikan deeings. Bon it! wheea can stay yey, sin' yey'ne a moind t' reet yursel'. T' coo's yur ain — nut t' parson's ner t' squire's. Dheh'se gude, bud dheh'se reet fond in sikan a case. Gin ah'd been left t' reckon wi' t' awd divvel, yur coo wad hev thraavun reet an' proper."

He clenched both fists, and his shaggy grey brows met in a savage frown.

John stood silent, looking straight before him, his face even sterner in expression than the old man's beside him.

"Ah wad dee 'at," he said at last. "Ah wad hev deean it wivout yer axing mah tweea tahmes, Joseph Sunley; bud it's t' lad George. He wonnot hev t' awd lass harmed, an' he awlus axes arter her."

Joseph stuck his pipe in his pocket, and then clasping each knee with a brown wrinkled hand, he looked up scoffingly in his neighbor's face.

"Wheea spoke o' harmin'? I'se seear 'at t' spillin' a drop o' deevil's bluid wad be a blessin' tiv t' witch isted o' harm. Sheea's reet full o' deeviltry, an' it would be a marcy to set some o' it free — mebbe she'll bost wiv it. Bud it's yur ain coo, neeghber, I'se nowt te deea wiv it — it's yur ain coo"

Mrs. Duncombe's flat round face and stout pillow-shaped figure came into the doorway of the next cottage.

"Good-day, Maister Barugh," she said. "Our Rose hev been t' Steersley t' day."

Barugh was glad of the interruption.

"Hev she that? An' hoo hev sheea foond them? Did sheea see Doris?"

He roared this out loudly, but Mrs. Duncombe only nodded her head, as if she did not quite hear him. She had not understood all the purport of Rose's complaints, but she had gathered that the girl was angry with Doris, and she had no mind to let the farmer know this. She did not want to quarrel with the Barughs, who were kind and neighborly in the way of skim-milk and vegetables, ay, and even to the extent of a bit of pork now and then.

But Rose's ears were sharp; and though she was up-stairs, she heard John's question. She put her head out of the bedroom window above.

"Gud evenin' to ye, Maister Barugh. I hev been to Steersley, an' I hev seen Mrs. Barugh an' Doris, but I didn't stay with 'em. Doris is such a grand lady. She's fair nunty, she is; I was shy like, an' I comed away," she ended with a broad laugh.

John Barugh had smiled as the pretty, rosy-cheeked damsel looked down at him, but he frowned again as she spoke of Doris. It seemed to him a sort of profanation that Rose should so speak.

"Ye deeant ken her, lass," he said reprovingly. "Doris is a lady noo, bud sheea's reet gude fer a' thaat."

Then he nodded to Mrs. Duncombe and Joseph, and moved slowly back to the farmyard.

Silence fell on the little group till he had passed through into the rick-yard and was out of sight.

Then Rose burst into a peal of laughter so loud and harsh that her grandmothe looked up and shook her head reprovingly.

"A lady!" Rose cried out. "My song! Doris a lady! Eh, ye sud hev seen my schoolmistress; she was a lady, I s'pose. Ye could tell it by her clothes. I don't believe Doris hev got so much as a silk gown to her back. She a lady, indeed! She never said so much as 'I'm glad to see you, Rose Duncombe.' She's a poor, pale, dowdy, aud-farrand, set-up thing; an' that's not what I calls a lady. So there!"

She drew in her head, and shut down the window with a bang.

Sunley laughed and slapped his knees with his hands.

"Woonkers! Sheea's a doonreet lass yon. She deean't miss t' neel," he said. "No luov lost atween her an' Doris, eh, neeghber?" But Mrs. Duncombe shook her head feebly and sighed. She knew something or some one was wrong, but she had only a hazy idea of life altogether. She heard a fragment here and a fragment there, but she had no wits to put them together, so that her mind was something like her patchwork counterpane, full of unconnected bits, which it was impossible to fit harmoniously.

John Barugh had taken away a far more definite idea of Rose's meaning. He was angry at first, and called the girl hard names to himself; but next day, and on the days after, he pondered the difference between Doris and Rose, and he grew more and more troubled. Doris seemed happy with him and her mother and George, but was she really happy, or was it only her good manners that kept her from showing disgust to them and their ways; and how would it be when they all settled down at Burneston, and Doris and Rose would be subject to the chance of meeting every day? John dreaded his next visit to Steersley; he dreaded to hear that there had been a quarrel with Rose Duncombe, and though she was pert to speak so of Doris, he was fond of the

bright pretty girl who had been so kind to George.

He usually went over on Saturday afternoon, but on this Friday the other sick cow was, to his surprise, recovering, and he thought he would surprise Dorothy next day by reaching Steersley for dinner at one o'clock. The place was very lonesome and dreary in the absence of its neat mistress, and Sally, the old woman who minded the house in Mrs. Barugh's absence, cleaned it from morning till night, till the smell of wet wood and soap grew overpowering.

It took John some time to put a thought into action, and while he stood twisting a bit of straw in his blunt red fingers, hesitating about his next day's journey, he saw Mr. Burneston coming from the glebefield into the rick-yard. The squire did not often come that way since he saw Doris swinging on the gate of the glebefield, but to-day he took a pleasure in the remembrance; he even lingered at the gate while the collie, who had been following his master, sprang forward, barking joyously when she saw the farmer.

"Weel, then — weel, then, awd lass." John stooped to pat her black head as she sprang up to caress him. "Thee's nut ane 'at forgits awd freends."

Mr. Burneston had come forward, and he heard the last words.

"Do you mean that for me, Mr. Barugh?" he smiled pleasantly as he held out his hand. "But I'm not so neglectful as you think. I hear of you whenever I go to Steersley. I heard of you only yesterday from Mrs. Barugh. How well George looks! It's plain Burneston does not suit him."

This speech jarred John on more than one point; first, by giving him the knowledge that Dorothy had concealed Mr. Burneston's visits from him, and next by the implied interference about George.

"Mebbe it's t' change, nut t' air," he spoke sullenly; "t' lad's awlus better for a change: 'tis so wiv young fooaks."

"I think the change benefits Mrs. Barugh too, she looks wonderfully bright since she's been at Steersley; the air seems to suit her."

One of John's shoulders was visibly nearer his ear than the other. "Yeh'ar wrang there, squire; t' aant t' air. Mah missus faands too mich tu deea i' t' house tu gan gaddin' after air; sheea's awlus weel at t' farm noo!"

"Ah, just so." Mr. Burneston looked about uneasily, and then he clasped both hands on the knob of his stick, and looked earnestly at the farmer. "I want to speak very seriously to you, Mr. Barugh; shall we go in-doors?"

John felt as awkward as he could, and his capacity for awkwardness was large; his hospitality checked the churlish answer he wanted to give, for an undefined shrinking warned him that Mr. Burneston's visit was bringing a shadow to his hearth.

"Coom in-doors then," he tried to speak heartily and went on first, but there was no welcoming smile on his face when he added, "Sit ye doon, squire; we'se noane so carded oop noo t' missus is at Steersley;" he gave an uneasy glance at the empty grate, which shone brightly, but looked cold.

For a moment the two men sat silent in the shining wooden high-backed armchairs on each side of the empty grate.

"I have, as you have doubtless heard," Mr. Burneston began — he took it for granted that his visits to Steersley had prepared the farmer for this interview — "seen a good deal of your daughter since she came home, and ——" He paused; the sound of a smothered execration disturbed him; but John was only frowning a little more heavily, and the sunburnt red of his cheeks was a trifle deeper than usual. Mr. Burneston went on, "I greatly admire her; and I think it right to tell you before I speak to her that I hope she will be my wife."

John swung round in his chair so as nearly to overturn it, but he steadied himself by a vigorous grasp at its wooden arms.

"Yur wife, squire! Din yee mean yee hev bin axing mah lass tu wed yee?" he rose up with stern wrath burning in his face.

Mr. Burneston felt angry too; he cursed the farmer's denseness, for evidently his carefully prepared preface had not been heeded.

"I said just now," in a stiff voice, "that I think it right to tell you my intention before I speak to Miss Barugh."

"An' noo to begin, ah says neea, neea, Maister Burneston. Deean't say nowt tu mah lass." John spoke stubbornly, anger and bitterness throbbing in every vein, till he hated the soft courtly gentleman who sat asking for what he prized most on earth — as if it were a bit of cake.

"But you won't say it," Mr. Burneston's sympathy helped him to guess at John's feelings; "I know you too well to believe that you will interfere with my happiness, and possibly too with your daughter's."

John straightened his tall, broad figure

till he and his red beard seemed to glower through the long low room.

"Maister Burneston, yey'ar quality," he said doggedly, "bud ah'd scorn tu deea 'at yey've bin deein'. Yey cooms an' tawks mah ower while ah sends mah lass tu skeeal, mah lass 'at war t' pride o' mah life! an' sehs yee, let her bide at skeeal, no coomin' yam, yey sehs; an' noo yey gans an' stihls her luove away fra mey 'at hev t' best reet tu 't, wivout a word, or sae mich as axing my leave — it's a burnin' shame, by God!" he clenched his fist and struck it heavily on the tall chair-back.

Mr. Burneston flushed to his temples, but he did not look cowed or ashamed. He made an effort to speak coolly. "We'd better sit down again, Mr. Barugh; you're angry, and you don't see things as they really are. I have been over to Steersley as I used to come here, and Mrs. Barugh always seemed glad to see me. Why should I have spoken to you beforehand? I could not be sure that I should become attached to your daughter."

John recovered himself a little; he would not sit down, but he wiped his forehead with his handkerchief. "Duov Doris care fer yee?" he asked abruptly.

"I cannot tell — I hope so."

"Then, in God's name, mon, leave her aleean. Keep awa fra Steersley, an' ah'll taak t' lass whoor sheea'll seea an' hear nowt aboot yee."

"This is folly;" and then Burneston smiled, and told himself he was as foolish as the farmer. "Try and look at the thing calmly, Mr. Barugh. Your daughter is certain to marry some one; she is far too attractive to be left in peace. Well, then, as she must take a husband why do you object to me? You ought to know me fairly well by this time. I love your daughter as a man should love the girl he means to make his wife; and I will spend my life in making her happy. Will you leave the decision to her? Give me leave to ask her, and I promise you to submit to the answer she gives."

There was silence. Mr. Burneston was surprised to find that he could hear his own heart beat in the intense anxiety he felt. This opposition was so utterly unlooked for.

At last John spoke hoarsely.

"Ah's a plain mon," he said; "bud ah deeant seea 'at gude ivver com o' sikan a marriage as yer wantin'. Yeh sud tak t' wife laake yursel', an' Doris wad be happier gin sheea tehk t' husband fra fooaks siken oursels. It's a mistak, Maister Burneston, fra beginnin' to t' end, yey aar gaain agin yur ain welfare, an' gin yey'll be guided yey'll keep awa from Steersley, and lihv Doris aleean."

Mr. Burneston took John's unwilling hand and shook it heartily. He had understood the farmer's nature far too well to say one word about any advantage that would accrue to Doris as mistress of Burneston; but he was greatly impressed by the simplicity and disinterestedness which could set so little value on worldly distinction.

"It's too late for me to do that," he said earnestly. "I never loved any woman as I love her, and no one else could make me so happy. I must try to win her; let me have your good-will in the matter, and remember that I consider your daughter fully my equal, and quite suited to be my wife."

John stood struggling with his pride; he felt that Doris as she was would be happier with such a man as the squire than in her own home; he knew it, and Mr. Burneston's words only stung the knowledge in with keener force, but it was too painful to acknowledge. He could not own that it was for himself that he longed so hungrily and jealously to keep his darling at home, nor could he bring himself to give a hearty consent to his landlord's wooing — he could not get out a word.

"Well, then," Mr. Burneston's smile was winning in its sweetness, "I am going on at once to Steersley. I am not ashamed to tell you, her father, that I cannot rest until I know my fate. Can I take any message from you?"

He stood waiting; he was not vexed with John's boorish silence. It was only natural, he thought. His admiration for the farmer's disinterestedness gave him new and warmer feeling for him. He prized Doris so highly, that he knew it must be very hard for John to give her up, and yet he could never have guessed at the mighty struggle that was wrenching the father's heart. At last Barugh spoke.

"Ye mun gan, ah caanut stay ye, bud ah caanut bid yeh God speed. Ah'd ginner thank yey fer settin' mah ricks o' fire. Deng it, ah caanut stay ye, an' thaat's as mich as ah caan tell yey noo."

John followed his visitor to the door, but he left him to cross the yard alone. He turned back to the parlor with a smothered oath.

"It's mah ain fondness ah sud curse," he said. "Ah wer nobbut a wake feeal; ah knawed it war wrang, an' jist fer tu

keep t' house quiet ah let her gan tu skeeal. Ah've arn'd all ah've getten."

He turned to the high mantelshelf, and pressed his hand against his forehead.

There was no outward sound, no groan or sigh, but in the unbroken silence he was reviewing a load of sorrow and bitterness — the five past years of his life, the more sorrowful, the more bitter, because reflection offered no salve for the past, no hope for the future.

John Barugh seldom communed with himself, but just now these five past years stood out in distinct periods to their first beginning — back even to that first day when he had been fool enough to show Doris to the squire, and then he stood suddenly upright.

Like the spell of a witch, or the memory of a curse, there came before him the blushing, shame-stricken face of his child, and, sounding clearly in the stillness, "the feeal's rhyme" of her confession, —

> May it so happen, an' may it so fall,
> Ah may be lady of Burneston Hall.

"Curse him!" he said fiercely; "he hev planned it fra te'hn end tiv t' id'ur."

From The Contemporary Review.

ON THE DISCOVERY OF OXYGEN IN THE SUN.

THE most promising result of solar research since Kirchhoff in 1859 interpreted the dark lines of the sun's spectrum has recently been announced from America. Interesting in itself, the discovery just made is doubly interesting in what it seems to promise in the future. Just as Kirchhoff's great discovery, that a certain double dark line in the solar spectrum is due to the vapor of sodium in the sun's atmosphere, was but the first of a long series of results which the spectroscopic analysis of the sun was to reveal, so the discovery just announced that a certain important gas — the oxygen present in our air and the chief chemical constituent of water — shows its presence in the sun by bright lines instead of dark, will in all probability turn out to be but the first-fruits of a new method of examining the solar spectrum. As its author, Dr. Henry Draper of New York, remarks, further investigation in the direction he has pursued will lead to the discovery of other elements in the sun, but it was not "proper to conceal the principle on which such researches are to be conducted, for the sake of personal advantage." It may well happen, though I anticipate otherwise, that by thus at once describing his method of observation, Dr. Draper may enable others to add to the list of known solar elements others which yet remain to be detected; but if Dr. Draper should thus have added but one element to that list, he will ever be regarded as the physicist to whose acumen the method was due by which all those elements were detected, and to whom, therefore, the chief credit of their discovery must certainly be attributed.

I propose briefly to consider the circumstances which preceded the great discovery which it is now my pleasing duty to describe, in order that the reader may the more readily follow the remarks by which I shall endeavor to indicate some of the results which seem to follow from the discovery, as well as the line along which in my opinion the new method may most hopefully be followed.

It is generally known that what is called the spectroscopic method of analyzing the sun's substance had its origin in Kirchhoff's interpretation of the dark lines in the solar spectrum. Until 1859 these dark lines had not been supposed to have any special significance, or rather it had not been supposed that their significance, whatever it might be, could be interpreted. A physicist of some eminence spoke of these phenomena in 1858 in a tone which ought by the way seldom to be adopted by the man of science. "The phenomena defy, as we have seen," he said, "all attempts hitherto to reduce them within empirical laws, and no complete explanation or theory of them is possible. All that theory can be expected to do is this — it may explain how dark lines of any sort may arise within the spectrum." Kirchhoff in 1859 showed not only how dark lines of any sort may appear, but how and why they do appear, and precisely what they mean. He found that the dark lines of the solar spectrum are due to the vapors of various elements in the sun's atmosphere, and that the nature of such elements may be determined from the observed position of the dark lines. Thus when iron is raised by the passage of the electric spark to so intense a degree of heat that it is vaporized, the light of the glowing vapor of iron is found to give a multitude of bright lines along the whole length of the spectrum — that is, some red, some orange, some yellow, and so on. In the solar spectrum corresponding dark lines are found along the whole length of the spectrum — that is, some in the red,

some in the orange, yellow, etc., and precisely in those parts of these various spectral regions which the bright lines of glowing iron would occupy. Multitudes of other dark lines exist of course in the solar spectrum. But those corresponding to the bright lines of glowing iron are unquestionably there. They are by no means lost in the multitude as might be expected, but, owing to the peculiarity of their arrangement, strength, etc., they are perfectly recognizable as the iron lines reversed, that is, dark instead of bright. Kirchhoff's researches showed how this is to be interpreted. It means that the vapor of iron exists in the atmosphere of the sun, glowing necessarily with an intensely bright light; *but*, being cooler (however intensely hot) than the general mass of the sun within, the iron vapor absorbs more light than it emits, and the result is that the iron lines, instead of appearing bright as they would if the iron vapor alone were shining, appear relatively dark on the bright rainbow-tinted background of the solar spectrum.

Thus was it shown that in the atmosphere of the sun there is the glowing vapor of the familiar metal, iron; and in like manner other metals, and one element (hydrogen) which is not ordinarily regarded as a metal, were shown to be present in the sun's atmosphere. In saying that they are present in the sun's atmosphere, I am, in point of fact, saying that they are present in the sun; for the solar atmosphere is, in fact, the outer part of the sun himself, since a very large part, if not by far the greater part, of the sun's mass must be vaporous. But no other elements, except the metals iron, sodium, barium, calcium, magnesium, aluminium, manganese, chromium, cobalt, nickel, zinc, copper, and titanium, and the element hydrogen, were shown to be present in the sun, by this method of observing directly the solar dark lines. In passing, I may note that there are reasons for regarding hydrogen as a metallic element, strange though the idea may seem to those who regard hardness, brightness, malleability, ductility, plasticity, and the like, as the characteristic properties of metals, and necessarily fail to comprehend how a gas far rarer, under the same conditions, than the air we breathe, and which cannot possibly be malleable, ductile, or the like, can conceivably be regarded as a metal. But there is in reality no necessary connection between any one of the above properties and the metallic nature; many of the fifty-five metals are wanting in all of these properties; nor is there any reason why, as we have in mercury a metal which at ordinary temperatures is a liquid, so we might have in hydrogen a metal which, at all obtainable temperatures, and under all obtainable conditions of pressure, is gaseous. It was shown by the late Professor Graham (aided in his researches most effectively by Dr. Chandler Roberts) that hydrogen will enter into such combination with the metal palladium that it may be regarded as forming, for the time, with the palladium, an alloy; and as alloys can only be regarded as compounds of two or more metals, the inference is that hydrogen is in reality a metallic element.

Fourteen only of the elements known to us, or less than a quarter of the total number, were thus found to be present in the sun's constitution; and of these all were metals, if we regard hydrogen as metallic. Neither gold nor silver shows any trace of its presence, nor can any sign be seen of platinum, lead, and mercury. But, most remarkable of all, and most perplexing, was the absence of all trace of oxygen and nitrogen, two gases which could not be supposed wanting in the substance of the great ruling centre of the planetary system. It might well be believed, indeed, that none of the five metals just named are absent from the sun, and indeed that every one of the forty metals not recognized by the spectroscopic method nevertheless exists in the sun. For according to the nebular hypothesis of the origin of our solar system, the sun might be expected to contain all the elements which exist in our earth. Some of these elements might indeed escape discovery, because existing only in small quantities; and others, as platinum, gold, and lead, for example, because but a small portion of their vaporous substance rose above the level of that glowing surface which is called the photosphere. But that oxygen, which constitutes so large a portion of the solid, liquid, and vaporous mass of our earth, should not exist in enormous quantities, and its presence be very readily discernible, seemed amazing indeed. Nitrogen, also, might well be expected to be recognizable in the sun. Carbon, again, is so important a constituent of the earth, that we should expect to discover clear traces of its existence in the sun. In less degree, similar considerations apply to sulphur, boron, silicon, and the other non-metallic elements.

It was not, however, supposed by any one at all competent to form an opinion on the subject, that oxygen, nitrogen, and car-

bon are absent from the sun. It was perceived that an element might exist in enormous quantities in the substance of the sun, and yet fail to give any evidence of its presence, or only give such evidence as might readily escape recognition. If we remember how the dark lines are really caused, we shall perceive that this is so. A glowing vapor in the atmosphere of the sun absorbs rays of the same color as it emits. If, then, it is cooler than the glowing mass of the sun which it enwraps, and if, notwithstanding the heat received from this mass, it remains cooler, then it suffers none of those rays to pass earthwards.* It emits rays of the same kind (that is, of the same *color*) itself, but, being cooler, the rays thus coming from it are feebler, or, to speak more correctly, the ethereal waves thus originated are feebler than those of the same order which *would* have travelled earthwards from the sun but for the interposed screen of vapor. Hence the corresponding parts of the solar spectrum are less brilliant, and contrasted with the rainbow-tinted streak of light on which they lie as on a background, they appear dark.

In order then that any element may be detected by its dark lines, it is necessary that it should lie as a vaporous screen between the more intensely heated mass of the sun and the eye of the observer on earth. It must then form an enclosing envelope cooler than the sun within it. Or rather, some part of the vapor must be thus situated. For enormous masses of the vapor might be within the photospheric surface of the sun at a much higher temperature, which yet being enclosed in the cooler vaporous shell of the same substance would not be able to send its light-rays earthwards. One may compare the state of things, so far as that particular element is concerned, to what is presented in the case of a metallic globe cooled on the outside but intensely hot within. The cool outside of such a globe is what determines the light and heat received from it, so long as the more heated mass within has not yet (by conduction) warmed the exterior shell. So in the case of a vapor permeating the entire mass, perhaps, of the sun, and at as high a temperature as the sun everywhere except on the outside. It is the temperature of the outermost part of such a vaporous mass which determines the intensity of the rays received from it — or in other words, determines whether the corresponding parts of the spectrum shall be darker or not than the rest of the spectrum. If the vapor does not rise above the photosphere of the sun in sufficient quantity to exercise a recognizable absorptive effect, its presence in the sun will not be indicated by any dark lines.

I dwell here on the question of quantity, which is sometimes overlooked in considering the spectroscopic evidence of the sun's condition, but is in reality a very important factor in determining the nature of the evidence relating to each element in the solar mass. In some cases, the quantity of a material necessary to give unmistakable spectroscopic evidence is singularly small; insomuch that new elements, as thallium, cæsium, rubidium, and gallium, have been actually first recognized by their spectral lines when existing in such minute quantities in the substances examined as to give no other trace whatever of their existence. But it would be altogether a mistake to suppose that some element existing in exceedingly small quantities, or, more correctly, existing in the form of an exceedingly rare vapor in the sun's atmosphere, would be detected by means of its dark lines, or *by any other method depending on the study of the solar spectrum.* When we place a small portion of some substance in the space between the carbon points of an electric lamp, and volatilize that substance in the voltaic arc, we obtain a spectrum including all the bright lines of the various elements contained in the substance; and if some element is contained in it in exceedingly small quantity, we may yet perceive its distinctive bright lines among the others (many of them far brighter) belonging to the elements present in greater quantities. But if we have (for example) a great mass of molten iron, the rainbow-tinted spectrum of whose light we examine from a great distance, and if a small quantity of sodium, or other substance which vaporizes at moderate temperatures, be cast into the molten iron so that the vapor of the added element presently rises above the glowing surface of the iron, no trace of the presence of this vapor would he shown in the spectrum observed from a distance. The part of the spectrum where the dark lines of sodium usually appear would, undoubtedly, be less brilliant than before, in the same sense that the sun may be said

* More strictly, it plays the same part as a glass screen before a glowing fire. When the heat of the fire falls on such a screen (through which light passes readily enough), it is received by the glass, warming the glass up to a certain point, and the warmed glass emits the heat thus received in all directions, thus scattering over a large space the rays which but for the glass would have fallen directly upon the objects which the screen is intended to protect.

to be less brilliant when the air is in the least degree moist than when it is perfectly dry; but the loss of brilliancy is as utterly imperceptible in the one case as it is in the other. In like manner, a vapor might exist in the atmosphere of the sun (above the photosphere, that is), of whose presence not a trace would be afforded in the spectroscope, for the simple reason that the absorptive action of the vapor, though exerted to reduce the brightness of particular solar rays or tints, would not affect those rays sufficiently for the spectroscopist to recognize any diminution of their lustre.

There is another consideration, which, so far as I know, has not hitherto received much attention, but should certainly be taken into account in the attempt to interpret the real meaning of the solar spectrum. Some of the metals which are vaporized by the sun's heat below the photosphere, may become liquid or even solid at or near the level of the photosphere. Even though the heat at the level of the photosphere may be such that, under ordinary conditions of pressure and so forth, such metals would be vaporous, the enormous pressure which must exist not far below the level of the photosphere may make the heat necessary for complete vaporization far greater than the actual heat at that level. In that case the vapor will in part condense into liquid globules, or, if the heat is considerably less than is necessary to keep the substance in the form of vapor, than it may in part be solidified, the tiny globules of liquid metal becoming tiny crystals of solid metal. We see both conditions fulfilled within the limits of our own air in the case of the vapor of water. Low down the water is present in the air (ordinarily) in the form of pure vapor; at a higher level the vapor is condensed by cold into liquid drops forming visible clouds (cumulus clouds), and yet higher where the cold is still greater, the minute water-drops turn into ice-crystals forming those light fleecy clouds called cirrus clouds by the meteorologist. Now true clouds of either sort may exist in the solar atmosphere even above that photospheric level which forms the boundary of the sun we see. It may be said that the spectroscope, applied to examine matter outside the photosphere, has given evidence only of vaporous cloud masses. The ruddy prominences which towers tens of thousands of miles above the surface of the sun, and the sierra (or as it is sometimes unclassically called the chromosphere) which covers usually the whole of the photosphere to a depth of about eight thousand miles, show only under spectroscopic scrutiny the bright lines indicating gaseity. But though this is perfectly true, it is also true that we have not here a particle of evidence to show that clouds of liquid particles, and of tiny crystals may not float over the sun's surface, or even that the ruddy clouds shown by the spectroscope to shine with light indicative of gaseity may not also contain liquid and crystalline particles. For in point of fact, the very principle on which our recognition of the bright lines depends involves the inference that matter whose light would *not* be resolved into bright lines would not be recognizable at all. The bright lines are seen, because by means of a spectroscope we can throw them far apart, without reducing their lustre, while the background of rainbow-tinted spectrum has its various portions similarly thrown farther apart and correspondingly weakened. One may compare the process (the comparison I believe has not hitherto been employed) to the dilution of a dense liquid in which solid masses have been floating: the more we increase the quantity of the liquid in diluting it with water, the more transparent it becomes, but the solid masses in it are not changed, so that we have only to dilute the liquid sufficiently to see these masses. *But* if there were in the interstices of the solid masses particles of some substance which dissolved in the water, we should not recognize the presence of this substance by any increase in its visibility; for the very same process which thinned the liquid would thin this soluble substance in the same degree. In like manner, by dispersing and correspondingly weakening the sun's light more and more we can recognize the light of the gaseous matter in the prominences, for this is not weakened; but if the prominences also contain matter in the solid or liquid form (that is, drops or crystals), the spectroscopic method will not indicate the presence of such matter, for the spectrum of such matter will be weakened by dispersion in precisely the same degree that the solar spectrum itself is weakened.

It is easy to see how the evidence of the presence of any element which behaved in this way would be weakened, if if we consider what would happen in the case of our own earth, according as the air were simply moist but without clouds, or loaded with cumulus masses but without cirrus clouds, or loaded with cirrus clouds. For although there

is not in the case of the earth a central glowing mass like the sun's, on whose rainbow-tinted spectrum the dark lines caused by the absorptive action of our atmosphere could be seen by the inhabitant of some distant planet studying the earth from without, yet the sun's light reflected from the surface of the earth plays in reality a similar part. It does not give a simple rainbow-tinted spectrum, for, being sunlight, it shows all the dark lines of the solar spectrum; but the addition of new dark lines to these, in consequence of the absorptive action of the earth's atmosphere, could very readily be determined. In fact we do thus recognize in the spectra of Mars, Venus, and other planets, the presence of aqueous vapor in their atmosphere, despite the fact that our own air, containing also aqueous vapor, naturally renders so much the more difficult the detection of that vapor in the atmosphere of remote planets necessarily seen through our own air. Now, a distant observer examining the light of our own earth on a day when, though the air was moist, there were no clouds, would have ample evidence of the presence of the vapor of water; for the light which he examined would have gone twice through our earth's atmosphere, from its outermost thinnest parts to the densest layers close to the surface, then back again through the entire thickness of the air. But if the air were heavily laden with cumulus clouds (without any cirrus clouds at a higher layer), although *we* should know that there was abundant moisture in the air, and indeed much more moisture than there had been when there had been no clouds, our imagined observer would either perceive no traces at all of this moisture, or he would perceive traces so much fainter than when the air was clear that he would be apt to infer that the air was either quite dry, or at least very much drier than it had been in that case. For the light which he would receive from the earth would not in this case have passed through the entire depth of moisture-laden air twice, but twice only through that portion of air which lay above the clouds, at whose surface the sun's light would be reflected. The whole of the most moisture-laden layer of the air would be snugly concealed under the cloud-layer, and would exercise no absorptive action whatever on the light which the remote observer would examine. If from the upper surface of the layer of cumulus clouds aqueous vapor rose still higher, and was converted in the cold upper regions of the atmosphere into clouds of ice-crystals, the distant observer would have still less chance of recognizing the presence of moisture in our atmosphere. For the layer of air between the cumulus clouds and the cirrus clouds would be unable to exert any absorptive action on the light which reached the observer. All such light would come to him after reflection from the layer of cirrus clouds. He would be apt to infer that there was no moisture at all in the air of our planet, at the very time when in fact there was so much moisture that not one layer only, but two layers of clouds enveloped the earth, the innermost layer consisting of particles of liquid water, the outermost of particles of frozen water. Using the words ice, water, and steam, to represent the solid, liquid and vaporous states of water, we may fairly say that ice and water, by hiding steam, would persuade the remote observer that there was no water at all on the earth —at least if he trusted solely to the spectroscopic evidence then obtained.*

We might in like manner fail to obtain any spectroscopic evidence of the presence of particular elements in the sun, because they cannot exist in sufficient quantity in the vaporous form in those outer layers which the spectroscope can alone deal with.

In passing I must note a circumstance in which some of those who have dealt with this special part of the spectroscopic evidence have erred. It is true in one sense that some elements may be of such

* The case here imagined is not entirely hypothetical. We examine Mercury and Venus very nearly under the conditions here imagined; for we can obtain only spectroscopic evidence respecting the existence of water on either planet. In the case of Mars we have telescopic evidence, and no one now doubts that the greenish parts of the planet are seas and oceans. But Venus and Mercury are never seen under conditions enabling the observer to determine the color of various parts of their discs.

I may add that a mistake, somewhat analogous to that which I have described in the cases of an imagined observer of our earth, has been made by some spectroscopists in the case of the planets Jupiter and Saturn. In considering the spectroscopic evidence respecting the condition of these planets' atmospheres, they have overlooked the circumstance that we can judge only of the condition of the outermost and coolest layers, for the lower layers are concealed from view by the enormous cloud masses, floating, as the telescope shows, in the atmospheric envelopes of the giant planets. Thus the German spectroscopist Vögel argues that because dark lines are seen in the spectrum of Jupiter which are known to belong to the absorption-spectrum of aqueous vapor, the planet's surface cannot be intensely hot. But Jupiter's absorption-spectrum belongs to layers of his atmosphere lying far above his surface. We can no more infer the actual temperature of Jupiter's surface from the temperature of the layers which produce his absorption-spectrum, than a visitor who should view our earth from outer space, observing the low temperature of the air ten or twelve miles above the sea-level, could infer thence the actual temperature of the earth's surface.

a nature that their vapors cannot rise so high in the solar atmosphere as those of other elements. But it must not be supposed that the denser vapors seek a lower level, the lighter vapors rising higher. According to the known laws of gaseous diffusion, a gas or vapor diffuses itself throughout a space occupied by another gas or several other gases, in the same way as though the space were not occupied at all. If we introduce into a vessel full of common air a quantity of carbonic-acid gas (I follow the older and more familiar nomenclature), this gas, although of much higher specific gravity than either oxygen or nitrogen, does not take its place at the bottom of the vessel, but so diffuses itself that the air of the upper part of the vessel contains exactly the same quantity of carbonic-acid gas as the air of the lower part. Similarly, if hydrogen is introduced, it does not seek the upper part of the vessel, but diffuses itself uniformly throughout the vessel. If we enclose the carbonic-acid gas in a light silken covering, and the hydrogen in another (at the same pressure as the air in the vessel) one little balloon will sink and the other will rise; but this is simply because diffusion is prevented. It may be asked how this agrees with what I have said above, that some elements may not exist in sufficient quantity or in suitable condition above the sun's photospheric level to give any spectroscopic evidence of their nature. As to quantity, indeed, the answer is obvious: if there is only a small quantity of any given element in the entire mass of the sun, only a very small quantity can under any circumstances exist outside the photosphere. As regards condition, it must be remembered that the vessel of my illustrative case was supposed to contain air at a given temperature and pressure throughout. If the vessel was so large that in different parts of it the temperature and pressure were different, the diffusion would, indeed, still be perfect, because at all ordinary temperatures and pressures hydrogen and carbonic-acid gas remain gaseous. But if the vapor introduced is of such a nature that at moderate temperatures and pressures it condenses, wholly or in part, or liquefies, the diffusion will not take place with the same uniformity. We need not go farther for illustration than to the case of our own atmosphere as it actually exists. The vapor of water spreads uniformly through each layer of the atmosphere which is at such a temperature and pressure as to permit of such diffusion; but where the temperature is too low for complete diffusion (at the actual pressure) the aqueous vapor is condensed into visible cloud, diffusion being checked at this point as at an impassable boundary. In the case of the sun, as in the case of our own earth, it is not the density of an element when in a vaporous form which limits its diffusion, but the value of the temperature at which its vapor at given pressure condenses into liquid particles. It is in this way only that any separation can be effected between the various elements which exist in the sun's substance, and though such separation is unquestionably competent to modify the spectroscopic evidence respecting different elements, it would be a mistake to suppose that any such separation could occur, as had been imagined by some — a separation causing in remote times the planets supposed to have been thrown off by the sun to be rarest on the outskirts of the solar system and densest close to the sun. The small densities of the outer family of planets, as compared with the densities of the so-called terrestrial planets, must certainly be otherwise explained.

But undoubtedly the chief circumstance likely to operate in veiling the existence of important constituents of the solar mass must be that which has so long prevented spectroscopists from detecting the presence of oxygen in the sun. An element may exist in such a condition, either over particular parts of the photosphere, or over the entire surface of the sun, that instead of causing dark lines in the solar spectrum it may produce bright lines. Such lines may be conspicuous, or they may be so little brighter than the background of the spectrum as to be scarcely perceptible or quite imperceptible.

In passing, I would notice that this interpretation of the want of all spectroscopic evidence of the presence of oxygen, carbon, and other elements in the sun, is not an *ex post facto* explanation. As will presently appear, it is now absolutely certain that oxygen, though really existing, and doubtless, in enormous quantities, in the sun, has been concealed from recognition in this way. But that this might be so was perceived long ago. I myself, in the first edition of my treatise on the sun, pointed out, in 1870, with special reference to nitrogen and oxygen, that an element "may be in a condition enabling it to radiate as much light as it absorbs, or else very little more or very little less, so that it either obliterates all signs of its existence, or else gives lines so little brighter or darker than the surrounding parts of

the spectrum that we can detect no trace of its existence." I had still earlier given a similar explanation of the absence of all spectroscopic evidence of hydrogen in the case of the bright star Betelgeux.*

Let us more closely consider the significance of what we learn from the spectral evidence respecting the gas hydrogen. We know that when the total light of the sun is dealt with, the presence of hydrogen is constantly indicated by dark lines. In other words, regarding the sun as a whole, hydrogen constantly reduces the emission of rays of those special tints which correspond to the light of this element. When we examine the light of other suns than ours, we find that in many cases, probably in by far the greater number of cases, hydrogen acts a similar part. But not in every case. In the spectra of some stars, notably in those of Betelgeux and Alpha Herculis, the lines of hydrogen are not visible at all; while in yet others, as Gamma Cassiopeiæ, the middle star of the five which form the straggling W of this constellation, the lines of hydrogen show bright upon the relatively dark background of the spectrum. When we examine closely the sun himself, we find that although his light as a whole gives a spectrum in which the lines of hydrogen appear dark, the light of particular parts of his surface, if separately examined, occasionally shows the hydrogen lines bright as in the spectrum of Gamma Cassiopeiæ, while sometimes the light of particular parts gives, like the light of Betelgeux, no spectroscopic evidence whatever of the presence of hydrogen. Manifestly, if the whole surface of the sun were in the condition of the portions which give bright hydrogen lines, the spectrum of the sun would resemble that of Gamma Cassiopeiæ; while if the whole surface were in the condition of those parts which show no lines of hydrogen, the spectrum of the sun would resemble that of Betelgeux. Now if there were any reason for supposing that the parts of the sun which give no lines of hydrogen are those from which the hydrogen has been temporarily removed in some way, we might reasonably infer that in the stars whose spectra show no hydrogen lines there is no hydrogen. But the fact that the hydrogen lines are sometimes seen bright, renders this supposition untenable. For we cannot suppose that the lines of hydrogen change from dark to bright or from bright to dark (both which changes certainly take place) without passing through a stage in which they are neither bright nor dark; in other words we are compelled to assume that there is an intermediate condition in which the hydrogen lines, though really existent, are invisible because they are of precisely the same lustre as the adjacent parts of the spectrum. Hence the evanescence of the hydrogen lines affords no reason for supposing that hydrogen has become even reduced in quantity where the lines are not seen. And therefore it follows that the invisibility of the hydrogen lines in the spectrum of Betelgeux is no proof that hydrogen does not exist in that star in quantities resembling those in which it is present in the sun. And this being demonstrated in the case of one gas, must be regarded as at least probable in the case of other gases. Wherefore the absence of the lines of oxygen from the spectrum of any star affords no sufficient reason for believing that oxygen is not present in that star, or that it is not as plentifully present as hydrogen, or even far more plentifully present.

There are other considerations which have to be taken into account, as well in dealing with the difficulty arising from the absence of the lines of particular elements from the solar spectrum as in weighing the extremely important discovery which has just been effected by Dr. H. Draper. I would specially call attention now to a point which I thus presented seven years ago: "The great difficulty of interpreting the results of the spectroscopic analysis of the sun arises from the circumstance that we have no means of learning whence that part of the light comes which gives the continuous spectrum. When we recognize certain dark lines, we know certainly that the corresponding element exists in the gaseous form at a lower temperature than the substance which gives the continuous spectrum. But as regards that continuous spectrum itself we can form no such exact opinion." It might, for

* In "Other Worlds than Ours," I wrote as follows: "The lines of hydrogen, which are so well marked in the solar spectrum, are not seen in the spectrum of Betelgeux. We are not to conclude from this that hydrogen does not exist in the composition of the star. We know that certain parts of the solar disc, when examined with the spectroscope, do not at all times exhibit the hydrogen lines, or may even present them as bright instead of dark lines. It may well be that in Betelgeux hydrogen exists under such conditions that the amount of light it sends forth is nearly equivalent to the amount it absorbs, in which case its characteristic lines would not be easily discernible. In fact, it is important to notice generally, that while there can be no mistaking the positive evidence afforded by the spectroscope as to the existence of any element in sun or star, the negative evidence supplied by the absence of particular lines is not to be certainly relied upon."

instance, have its origin in glowing liquid or solid matter; but it might also be compounded of many spectra, each containing a large number of bands, the bands of one spectrum filling up the spaces which would be left dark between the bands of another spectrum, and so on until the entire range from the extreme visible red to the extreme visible violet were occupied by what appeared as a continuous rainbow-tinted streak. "We have, in fact, in the sun," as I pointed out, "a vast agglomeration of elements, subject to two giant influences, producing in some sort opposing effects — viz., a temperature far surpassing any we can form any conception of, and a pressure (throughout nearly the whole of the sun's globe) which is perhaps even more disproportionate to the phenomena of our experience. Each known element would be vaporized by the solar temperature at known pressures; each (there can be little question) would be solidified by the vast pressures, did these arise at known temperatures. Now whether, under these circumstances, the laws of gaseous diffusion prevail where the elements *are* gaseous in the solar globe; whether, where liquid matter exists it is in general bounded in a definite manner from the neighboring gaseous matter; whether any elements at all are solid, and if so under what conditions their solidity is maintained and the limits of the solid matter defined — all these are questions which *must* be answered before we can form a satisfactory idea of the solar constitution; yet they are questions which we have at present no means of answering." Again, we require to know whether any process resembling combustion can under any circumstances take place in the sun's globe. If we could assume that some general resemblance exists between the processes at work upon the sun and those we are acquainted with, we might imagine that the various elements ordinarily exist in the sun's globe in the gaseous form (chiefly) to certain levels, to others chiefly in the liquid form, and to yet others chiefly in the solid form. But even then that part of each element which is gaseous may exist in two forms having widely different spectra (in reality in five, but I consider only the extreme forms) — that whose light is capable of giving characteristic spectra of lines or bands (which will be different according to pressure and may appear either dark or bright), and that portion whose light is capable of giving a spectrum nearly or quite continuous.

It will be seen that Dr. H. Draper's discovery supplies an answer to one of the questions, or rather to one of the sets of questions, thus indicated. I give his discovery as far as possible in his own words.

Oxygen discloses itself [he says] *by bright lines or bands in the solar spectrum*, and does not give dark absorption-lines like the metals. We must therefore change our theory of the solar spectrum, and no longer regard it merely as a continuous spectrum with certain rays absorbed by a layer of ignited metallic vapors, but as having also bright lines and bands superposed on the background of continuous spectrum. Such a conception not only opens the way to the discovery of others of the non-metals, sulphur, phosphorus, selenium, chlorine, bromine, iodine, fluorine, carbon, etc., but also may account for some of the so-called dark lines, by regarding them as intervals between bright lines. It must be distinctly understood that in speaking of the solar spectrum here, I do not mean the spectrum of any limited area upon the disc or margin of the sun, but the spectrum of light from the whole disc.

In support of the important statement here advanced, Dr. Draper submits a photograph of part of the solar spectrum with a comparison spectrum of air, and also with some of the lines of iron and aluminium. The photograph itself, a copy of which, kindly sent to me by Dr. Draper, lies before me as I write, fully bears out Dr. Draper's statement. It is absolutely free from handwork or retouching, except that reference letters have been added in the negative. It shows the part of the solar spectrum between the well-known Fraunhofer lines G and H, of which G (an iron line) lies in the indigo, and H (a line of hydrogen) in the violet, so that the portion photographed belongs to that region of the spectrum whose chemical or actinic energy is strongest. Adjacent to this lies the photograph of the air lines, showing nine or ten well-defined oxygen lines or groups of lines, and two nitrogen bands. The exact agreement of the two spectra in position is indicated by the coincidence of bright lines of iron and aluminium included in the air spectrum with the dark lines of the same elements in the solar spectrum. "No close observation," as Dr. Draper truly remarks, "is needed to demonstrate to even the most casual observer" (of this photograph) "that the oxygen lines are found in the sun as bright lines." There is in particular one quadruple group of oxygen lines in the air spectrum, the coincidence of which with a group

of bright lines in the solar spectrum is unmistakable.

This oxygen group alone is almost sufficient, [says Dr. Draper] to prove the presence of oxygen in the sun, for not only does each of the four components have a representative in the solar group, but the relative strength and the general aspect of the lines in each case is similar.* I shall not attempt at this time [he proceeds] to give a complete list of the oxygen lines, . . . and it will be noticed that some lines in the air spectrum which have bright analogues in the sun are not marked with the symbol of oxygen. This is because there has not yet been an opportunity to make the necessary detailed comparisons. In order to be certain that a line belongs to oxygen, I have compared, under various pressures, the spectra of air, oxygen, nitrogen, carbonic acid, carburetted hydrogen, hydrogen, and cyanogen.

As to the spectrum of nitrogen and the existence of this element in the sun there is not yet certainty. Nevertheless, even by comparing the diffused nitrogen lines of this particular photograph, in which nitrogen has been sacrificed to get the best effect for oxygen, the character of the evidence appears. There is a triple band somewhat diffused in the photograph belonging to nitrogen, which has its appropriate representative in the solar spectrum, and another band of nitrogen is similarly represented. [Dr. Draper states that] in another photograph a heavy nitrogen line which in the present one lies opposite an insufficiently exposed part of the solar spectrum corresponds to a comparison band in the sun.

But one of the most remarkable points in Dr. Draper's paper is what he tells us respecting the visibility of these lines in the spectrum itself. They fall as I have mentioned in a part of the spectrum where the actinic energy is great but the luminosity small; in fact while this part of the spectrum is the very strongest for photography, it is close to the region of the visible spectrum,

> Where the last gleamings of refracted light
> Die in the fainting violet away.

It is therefore to be expected that those, if any, of the bright lines of oxygen, will be least favorably shown to direct vision, and most favorably in what might almost be called photographic vision, where we see what photography records for us. Yet Dr. Draper states that these bright lines of oxygen can be readily seen. "The bright lines of oxygen in the spectrum of the solar disc have not been hitherto perceived, probably from the fact that in eye-observation bright lines on a less bright background do not make the impression on the mind that dark lines do. When attention is called to their presence they are readily enough seen, even without the aid of a reference spectrum. The photograph, however, brings them into greater prominence." As the lines of oxygen are by no means confined to the indigo and violet, we may fairly hope that the bright lines in other parts of the spectrum of oxygen may be detected in the spectrum of the sun, now that spectroscopists know that bright lines and not dark lines are to be looked for.

Dr. Draper remarks that from purely theoretic considerations derived from terrestrial chemistry, and the nebular hypothesis, the presence of oxygen in the sun might have been strongly suspected; for this element is currently stated to form eight-ninths of the water of the globe, one-third of the crust of the earth, and one-fifth of air, and should therefore probably be a large constituent of every member of the solar system. On the other hand, the discovery of oxygen, and probably other non-metals, in the sun gives increased strength to the nebular hypothesis, because to many persons the absence of this important group has presented a considerable difficulty. I have already remarked on the circumstance that we cannot, according to the known laws of gaseous diffusion, accept the reasoning of those who have endeavored to explain the small density of the outer planets by the supposition that the lighter gases were left behind by the great contracting nebulous mass, out of which, on the nebular hypothesis, the solar system is supposed to have been formed. It is important to notice, now, that if on the one hand we find in the community of structure between the sun and our earth, as confirmed by the discovery of oxygen and nitrogen in the sun, evidence favoring the theory according to which all the members of that system were formed out of what was originally a single mass, we do not find evidence against the theory (as those who have advanced the explanation above referred to may be disposed to imagine) in the recognition in the sun's mass of enormous quantities of one of these elements which, according to their view, ought to be found chiefly in the outer members of the solar system. If those who believe in the nebular hypothesis (generally, that is, for many of the details of the hypothesis as advanced by Laplace are entirely untenable in the pres-

* Dr. Draper remarks here in passing, "I do not think that, in comparisons of the spectra of the elements and sun, enough stress has been laid on the general appearance of lines apart from their mere position; in photographic representations this point is very prominent."

ent position of physical science) had accepted the attempted explanation of the supposed absence of the non-metallic elements in the sun, they would now find themselves in a somewhat awkward position. They would, in fact, be almost bound logically to reject the nebular hypothesis, seeing that one of the asserted results of the formation of our system, according to that hypothesis, would have been disproved. But so far as I know, no supporter of the nebular hypothesis possessing sufficient knowledge of astronomical and physical laws of facts to render his opinion of any weight, has ever given in his adhesion to the unsatisfactory explanation referred to.

The view which I have long entertained respecting the growth of the solar system — viz., that it had its origin not in contraction only or chiefly, but in combined processes of contraction and accretion — seems to me to be very strongly confirmed by Dr. Draper's discovery. This would not be the place for a full discussion of the reasons on which this opinion is based, nor does space indeed permit such a discussion. But I may remark that I believe no one who applies the laws of physics, *as at present known*, to the theory of the simple contraction of a great nebulous mass formerly extending far beyond the orbit of Neptune, till, when planet after planet had been thrown off, the sun was left in his present form and condition in the centre, will fail to perceive enormous difficulties in the hypothesis, or to recognize in Dr. Draper's discovery a difficulty added to those affecting the hypothesis *so presented*. Has it ever occurred, I often wonder, to those who glibly quote the nebular theory as originally propounded, to inquire how far some of the processes suggested by Laplace are in accordance with the now known laws of physics? To begin with, the original nebulous mass extending to a distance exceeding the earth's distance from the sun more than thirty times (this being only the distance of Neptune), if we assign to it a degree of compression making its axial diameter half its equatorial diameter, would have had a volume exceeding the sun's (roughly) about one hundred and twenty billion times, and in this degree its mean density would have been less than the sun's. This would correspond to a density equal (roughly) to about one four-hundred-thousandth part of the density of hydrogen gas at atmospheric pressure. To suppose that a great mass of matter having this exceedingly small mean density, and extending to a distance of three or four thousand millions of miles from its centre, could under any circumstances rotate as a whole, or behave in other respects after the fashion attributed to the gaseous embryon of the solar system in ordinary descriptions of the nebular hypothesis, is altogether inconsistent with correct ideas of physical and dynamical laws. It is absolutely a necessity of any nebular hypothesis of the solar system, that from the very beginning a central nucleus and subordinate nuclei should form in it, and grow according to the results of the motions (at first to all intents and purposes independent) of its various parts. Granting this state of things, we arrive, by considering the combined effects of concretion and contraction, at a process of development according fully as well as that ordinarily described with the general relations described by Laplace, and accounting also (in a general way) for certain peculiarities which are in no degree explained by the ordinary theory. Amongst these may specially be noted the arrangement and distribution of the masses within the solar system, and the fact that so far as spectroscopic evidence enables us to judge, a general similarity of structure exists throughout the whole of the system.

Inquiring as to the significance of his discovery, Dr. Draper remarks that it seems rather difficult

at first sight to believe that an ignited* gas in the solar atmosphere should not be indicated by dark lines in the solar spectrum, and should appear not to act under the law, "A gas when ignited absorbs rays of the same refrangibility as those it emits." But in fact the substances hitherto investigated in the sun are really metallic vapors, hydrogen probably coming under that rule. The non-metals obviously may behave differently. It is easy to speculate on the causes of such behavior; and it may be suggested that the reason of the non-appearance of a dark line may be that the intensity of the light from a great thickness of ignited oxygen overpowers the effect of the photosphere, just as, if a person were to look at a candle-flame through a yard thickness of sodium vapor, he would only see bright sodium lines, and no dark absorption.

The reasoning here is not altogether satis-

* The word "ignited" may mislead, and indeed is not correctly used here. The oxygen in the solar atmosphere, like the hydrogen, is simply glowing with intensity of heat. No process of combustion is taking place. Ignition, strictly speaking, means the initiation of the process of combustion, and a substance can only be said to be ignited when it has been set burning. The word *glowing* is preferable; or if reference is made to heat and light combined, then "glowing with intensity of heat" seems the description most likely to be correctly understood.

factory (or else is not quite correctly expressed). In the first place, the difficulty dealt with has no real existence. The law that a gas when glowing absorbs rays of the same refrangibility as those it emits, does not imply that a gas between a source of light and the observer will show its presence by spectroscopic dark lines. A gas so placed *does* receive from the source of light rays corresponding to those which it emits itself, if it is cooler than the source of light; and it absorbs them, being in fact heated by means of them, though the gain of temperature may be dissipated as fast as received: but if the gas is hotter, it emits more of those rays than it absorbs, and will make its presence known by its bright lines. This is not a matter of speculation, but of experiment. On the other hand, the experiment suggested by Dr. Draper would not have the effect he supposes, if it were correctly made. Doubtless if the light from a considerable area of dully glowing sodium vapor were received by the spectroscope at the same time as the light of a candle-flame seen through the sodium vapor, the light of the sodium vapor overcoming that of the candle-flame would indicate its presence by bright lines; but if light were received only from that portion of the sodium vapor which lay between the eye and the candle-flame, then I apprehend that the dark lines of sodium would not only be seen, but would be conspicuous by their darkness.

It is in no cavilling spirit that I indicate what appears to me erroneous in a portion of Dr. Draper's reasoning on his great discovery. The entire significance of the discovery depends on the meaning attached to it, and therefore it is most desirable to ascertain what this meaning really is. There can be no doubt, I think, that we are to look for the true interpretation of the brightness of the oxygen lines in the higher temperature of the oxygen, not in the great depth of oxygen above the photospheric level. The oxygen which produces these bright lines need not necessarily be above the photosphere at all. (In fact I may remark here that Dr. Draper, in a communication addressed to myself, mentions that he has found no traces at present of oxygen above the photosphere, though I had not this circumstance in my thoughts in reasoning down to the conclusion that the part of the oxygen effective in showing these bright lines lies probably below the visible photosphere.) Of course, if the photosphere were really composed of glowing solid and liquid matter, or of masses of gas so compressed and so intensely heated as to give a continuous spectrum, no gas existing below the photosphere conld send its light through, nor could its presence, therefore, be indicated in any spectroscopic manner. But the investigations which have been made into the structure of the photosphere as revealed by the telescope, and in particular the observations made by Professor Langley, of the Alleghany Observatory, show that we have not in the photosphere a definite bounding envelope of the sun, but receive light from many different depths below that spherical surface, four hundred and twenty-five thousand miles from the sun's centre, which we call the photospheric level. We receive more light from the centre of the solar disc, I feel satisfied, not solely because the absorptive layer through which we there see the sun is shallower, but partly, and perhaps chiefly, because we there receive light from some of the interior and more intensely heated parts of the sun.* Should this prove to be the case, it may be found possible to do what heretofore astronomers have supposed to be impossible — to ascertain in some degree how far and in what way the constitution of the sun varies below the photosphere, which, so far as ordinary telescopic observation is concerned, seems to present a limit below which researches cannot be pursued.

I hope we shall soon obtain news from Dr. Huggins's observatory that the oxygen lines have been photographed and possibly the bright lines of other elements recognized in the solar spectrum. Mr. Lockyer also, we may hope, will exercise that observing skill which enabled him early to recognize the presence of bright hydrogen lines in the spectrum of portions of the sun's surface, to examine that spectrum for other bright lines.

I do not remember any time within the last twenty years when the prospects of fresh solar discoveries seemed more hopeful than they do at present. The interest which has of late years been drawn to the subject has had the effect of enlisting fresh recruits in the work of observation, and

* It would be an interesting experiment, which I would specially recommend to those who, like Dr. Draper, possess instrumental means specially adapted to the inquiry, to ascertain what variations, if any, occur in the solar spectrum when (i.) the central part of the disc alone, and (ii.) the outer part alone, is allowed to transmit light to the spectroscope. The inquiry seems specially suited to the methods of spectral photography pursued by Dr. Draper, and by Dr. Huggins in this country. Still I believe interesting results can be obtained even without these special appliances; and I hope before long to employ my own telescope in this department of research.

many of these may before long be heard of as among those who have employed Dr. Draper's method successfully.

But I would specially call attention to the interest which attaches to Dr. Draper's discovery and to the researches likely to follow from it, in connection with a branch of research which is becoming more and more closely connected year by year with solar investigations — I mean stellar spectroscopy. We have seen the stars divided into orders according to their constitution. We recognize evidence tending to show that these various orders depend in part upon age, — not absolute but relative age. There are among the suns which people space some younger by far than our sun, others far older, and some in a late stage of stellar decrepitude. Whether as yet spectroscopists have perfectly succeeded in classifying these stellar orders in such sort that the connection between a star's spectrum and the star's age can be at once determined, may be doubtful. But certainly there are reasons for hoping that before long this will be done. Amongst the stars, and (strange to say) among celestial objects which are not stars, there are suns in every conceivable stage of development, from embryon masses not as yet justly to be regarded as suns, to masses which have ceased to fulfil the duties of suns. Among the more pressing duties of spectroscopic analysis at the present time is the proper classification of these various orders of stars. Whensoever that task shall have been accomplished, strong light, I venture to predict, will be thrown on our sun's present condition, as well as on his past history, and on that future fate upon which depends the future of our earth.

RICHARD A. PROCTOR.

This story ("GREEN PASTURES AND PICCADILLY"), *being written partly in collaboration with an American author, is copyrighted both in this country and in England, and is printed in* THE LIVING AGE *from Harper's Bazar, by arrangement with Harper & Brothers.*

GREEN PASTURES AND PICCADILLY.

BY WILLIAM BLACK,

AUTHOR OF "THE PRINCESS OF THULE," "THE ADVENTURES OF A PHAETON," ETC.,

In conjunction with an American writer.

CHAPTER XLII.

LIFE ON WHEELS.

WE rub our eyes. Have we wandered into a Brazilian swamp, then, during the long dark night? The yellow light of the early morning is shining down on those dusky pools of sluggish water, on the dense forest, on the matted underwood, and rank green grass. How the railway track does not sink into this vast mere passes our comprehension; there seems scarcely sufficient mud on these scattered islands to support the partly submerged trees. But, as we are looking out, a new object suddenly confronts the eyes. Instead of that succession of still creeks we come on a broad expanse of coffee-colored water that broadens out as it rolls southward; and we cry, "The Mississippi!" And over there, on the other side, we see a big and straggling town picturesquely built along the bluffs, and all shining in the early sunlight. But the Mississippi detains us not, nor Burlington either. Our mission is westward, and forever westward — through the perpetual forest, with its recurrent clearances and farms and fields of maize. Surely it is a pleasant enough manner of passing this idle, beautiful day. The recent rains have laid the dust; we sit outside the car and lazily watch the rich colors of the underwood as we pass. Could any thing be deeper in hue than the lake-red of those sumach bushes? Look at that maple — its own foliage is a mass of pale transparent gold; but up the stem and out the branches runs a creeper, and the creeper is of a pure vermilion that burns in the sun. Westward — and forever westward. We lose consciousness of time. We resign ourselves to the slow passing-by of the trees, and the farms, and the maize. It is like a continuous dream.

And was this, we asked ourselves — was this, after all, America? In the bygone days, before we ever thought of putting foot on this vast continent, we had our imaginary pictures of it; and surely these were bigger and nobler things than this trivial recurrence of maize, maize, maize — an occasional house — endless trees and bushes, and bushes and trees? Who does not remember those famous words that thrilled two nations when they were spoken? "I have another and a far brighter vision before my gaze. It may be but a vision, but I will cherish it. I see one vast confederation stretching from the frozen North in unbroken line to the glowing South, and from the wild billows of the Atlantic to the calmer waters of the Pacific main — and I see one people, and one language, and one law, and one faith, and, over all that wide continent, the home of freedom, and a refuge for the op-

pressed of every race and of every clime." But where were the condor's wings to give us this vision, now that we were about midway between the Atlantic and the Rocky Mountains? We only saw maize. And then we tried to imagine an American's mental picture of England — something composed of Stratford-on-Avon, and Westminster Abbey, and Rydal Mount, and Milton, and Shakespeare, and Cromwell — and his bitter disappointment on sailing up the Mersey and coming into view of the squalor of Liverpool. This was the nonsense that got into our heads on this sleepy and sunny day.

But by-and-by the horizon widened, for we had been slowly ascending all this time; and you may be sure there was a little excitement throughout our party when we began to get our first glimpses of the prairie land. Not the open prairie just yet; but still such suggestions of it as stirred the mind with a strange and mysterious feeling. And, of course, all our preconceived notions about the prairies were found to be wrong. They were not at all like the sea. They were not at all melancholy and oppressive. On the contrary, they were quite cheerful and bright in the sunshine; though there was still that mysterious feeling about them, and though the unaccustomed eye could not get quite reconciled to the absence from the horizon of some line of hill, and would keep searching for some streak of blue. Surely there was nothing here of the dreary wastes we had imagined? First of all, and near us, was a rich wilderness of flowers, of the most bountiful verdure and variegated colors — masses of yellow sunflowers, and lilac Michaelmas daisies, and what not, with the blood-red of the sumach coming in. Further off the plain rose and fell in gentle undulations covered with variously-tinted grass; and here and there were the palisades of a few ranches. Further away still were wider and barer undulations, marked by one or two clusters of the minutest specks, which we took to be cattle. Then beyond that again the open prairie land — long, level swathes of the very faintest russet, and grey-green, and yellow-gray, going out — out — out until the blue sky of the horizon seemed quite close and near to us compared with that ever and mysteriously receding plain. This vast distance was not awful, like the sea. It was beautiful in its pale colors; it was full of an eager interest — for the eye appealed to the imagination to aid it in its endless search; and if it was an ocean at all it was an ocean that broke at our feet in a brilliant foam of flowers. This similitude was, indeed, so obvious that we unanimously were of opinion that it must have been used by every American poet who has ever written about the prairie lands.

We had for our nearest travelling companions two commercial gentlemen of a facetious turn, who certainly did their best to amuse our women-folk. It was the lieutenant, of course, who had made their acquaintance. One was a Philadelphian, the other a New Yorker; but both were in the sewing-machine business; and it was their account of their various experiences in travelling that had induced Von Rosen to join their conversation. They were merry gentlemen. They ventured to ask what might be his line of business — white goods, or iron, or Western produce?

"And if it is white goods, what then?" said the ex-soldier, with great *sang-froid*.

"Why, sir," said the Philadelphian, gravely taking out a number of cards, "because money is money, and biz is biz; and you want to know where to buy cheap. That's Philadelphia sure — the American metropolis — the largest city in the world — yes, *sir!* — eighteen miles by eight — two rivers — going to have the Centennial — the best shad ——"

He was regarding the New Yorker all this time.

"Yes — shad!" said his companion, with affected contempt; for we could see that they were bent on being amiably funny. "If you want shad, go to Philadelphia — and cat-fish, too — cat-fish suppers at the Falls only seventy-five cents a head. And fresh butter, too — go to Philadelphia for fresh butter, and reed-birds, and country board — best country board outside of Jersey — keep their own cows — fresh milk, and all that. But if you WANT TO TRADE, colonel, come to New York! New York ain't no village — no one-horse place — no pigs around our streets. We've got the finest harbor in the world, the highest steeples, the noblest park, the greatest newspapers, the most magnificent buildings — why, talk about your Coliseums, and Tuileries, and Whitechapel, and them one-horse shows — come and see our Empire City!"

"Yes; and leave your purse in Philadelphia before you go!" sneered his enemy, who quite entered into the spirit of the thing. "And ask your friend here to show you the new Court-house, and tell you how much *that* cost! Then let him drive you up the avenues, and have

your life insured before you start, and show you the tar-and-sand, the mush-and-molasses pavements — patent pavements! Then ask him to introduce you to his friend the Boss, and mebbe he'll tell you how much the Boss got away with. And then about the malaria? And the fever and ague? And the small-pox? And people dying off so fast they've got to run special trains for the corpses? And the Harlem Flats?"

"Now hire a hall, won't you?" said the Knickerbocker. "Hasn't our cat got a long tail! Why, you could roll up Philadelphia into a bundle and drop it into a hole in the Harlem Flats. But I wouldn't mislead you — no, sir. If you want water-power, go to Philadelphia — and grass — splendid grass — and mosquitoes. Tell him about the mosquitoes, now! Friend of mine in the sugar-line married and went to Philadelphia for his honeymoon. Liked a quiet country life — no racket, except the roosters in the morning — liked the cows, and beauties of nature — and took his bride to a first-class hotel. Fine girl — bin chief engineer on a double-stitch sewing-machine. Well, sir, the Philadelphia mosquitoes were alive — you bet. In the morning he took her to a hospital — certain she had small-pox — two weeks before the doctors could find it out. The man's life was ruined — yes, sir — never recovered from the shock; business went to the dickens; and he ran away and jined the Mormons."

"Jined the Mormons!" cried the Philadelphian. "Why don't you tell the general the story straight? Don't fool the man. Jined the Mormons! He threw her into a sugar-vat — sweets to the sweet, sez he — and married her mother, and went to New York, and was elected mayor as the friend of Ireland — eleven hundred thousand Irishmen, all yelling for the pope, voted for him. No, general, if you want to trade with Americans, with white men, you come to Philadelphia; we live cheap and we sell cheap; and with our new line of steamers, and our foreign trade ——"

"Tell him about the canal-boats — why don't you tell him about the three canal-boats?" said the other scornfully. "It is a fact, general — when three canal-boats loaded with pop-corn and sauer-kraut got to Philadelphia, the mayor called out the militia for a parade — yes, *sir!* — the town was illuminated; the newspapers had leaders on the revival of commerce, and the people all had two inches sewed on to their coat-tails. And mind, general, when you go to Philadelphia, you tell the conductor where to stop — tell him the wood-and-water station opposite Camden — the train stops by signal ——"

Whither this conflict might have led us can only be conjectured. It was interrupted by our halting at a small station to have a midday dinner. And we did not fail to remark that the shy and handsome girls who waited on the crowd of ravenous people in this humble hostelry had bright complexions and clear eyes that spoke well for the air of this high-lying country. The lieutenant was furious because he could get nothing but water or iced tea to drink. His wife remarked that she hoped he would always be as well off, showing that she had had her speculations about her probable life as a ranch-woman. But another member of the party was anxious to get away as soon as possible from the devouring multitude; and when she was outside again, on the platform, she revealed the cause of that pensiveness that had at times dwelt over her face during the morning.

"Really now, *really*, do you think I was right?" she says in a low voice. "I have been thinking over it. It seems so cruel. The poor thing is just breaking her heart over the mistake she has made — in ever leaving him; and now, when she would have this excuse, this opportunity of appealing to him, of going to him without any appeal, it seems dreadful to keep her in ignorance."

"Tell her, then."

"But the responsibility is terrible," she pleads again.

"Certainly. And you absolve yourself by waiting to know what Balfour's wishes are. What more?"

"If — if I had a daughter — of her age," she says, with the usual quiver of the under lip, "I do not think I should let her go further and further away from her husband just when there was a chance of reconciling them ——"

"Will the chance be less next week, or the week after? However, do as you like. If you tell her, you must appeal to her not to do anything rash. Say you have written. Or you might suggest, if she is so very penitent, that she should write to her husband ——"

"Oh, may I do that?" exclaims this tender-eyed hypocrite, as if she ever demanded permission to do anything she had set her mind on.

You never saw one woman so pet another as she petted Lady Sylvia during the rest of that day. She had never shown so

much solicitous attention for the comfort of her own children, as far as any of us had ever noticed. And it was all because, no doubt, she was looking forward to a sentimental scene when we should arrive at Omaha, in which she should play the part of a beneficent fairy, and wise counsellor, and earnest friend. Happily it did not occur to her to have a scene in the railway car before a score of people.

This railway car, as the evening fell, was a sore distress to us. Our wish to have that fleeting glimpse of the Mississippi had led us to come on from Chicago by one of the slow trains, and from Burlington there was no Pullman car. Ordinarily this is about the pleasantest part of the long trans-continental ride from New York to San Francisco; for on it are dining-cars, which have within their narrow compass pretty nearly every luxury which the fancy of man could desire, and which therefore offer a capital way of passing the time. If one must go on travelling day after day without ceasing, it is surely a pleasant thing to occupy the last two or three hours of the evening by entertaining your friends to a banquet — and if you are alone, the conductor will accept an off-hand invitation — of twelve or fourteen dishes, while the foaming grape of eastern France, if Catawba will not content you, is hard by in an iced cellar. With these wild delights we should have been disposed to dispense had we obtained the comparative seclusion of a Pullman car; but as the long and dull evening set in we learned something of the happiness of travelling in an ordinary car in America. During the day we had spent most of the time outside; now we had to bear with what composure we could show the stifling odors of this huge and overcrowded compartment, while the society to which we were introduced was not at all fastidious in its language, or in its dress, or in the food which it plentifully ate. The lieutenant said nothing when a drunken woman sat down on his top-coat and refused to allow it to be removed; but he did remonstrate pitifully against the persistent shower of beetles that kept falling on our heads and necks. We could not understand whence these animals came. Their home could not be the roof of the car, for they were clearly incapable of maintaining a footing there. Or were we driving through an Egyptian plague of them; and did they come in through the ventilators? It was a miserable evening. The only escape from the foul odors and the talk and the shreds of food was sleep; and the close atmosphere gave its friendly help; but sleep is apt to disarrange one's head-covering; and then, that guard removed, the sudden sensation of having a beetle going down the back of one's neck banishes sweet dreams. About half past eight or nine we got to Council Bluffs; and right glad were we to get out for a walk up and down the wet platform — for it had been raining — in the pitch darkness.

Nor shall we forget Council Bluffs soon. We spent three mortal hours there. All that we saw was a series of planks, with puddles of dirty water reflecting the light of one or two gas-lamps. We were now on one bank of the Missouri; and Omaha, our destination, was immediately on the other side, while there intervened an iron bridge. An engine would have taken us across and returned in a very short time. But system must be followed. It was the custom that the passengers by our train should be taken over in company with those arriving by a train due from somewhere else; and as that train had not made its appearance, why should we not continue to pace up and down the muddy platform? It was not the least part of our anxiety that, after an hour or so had passed, ex-Lieutenant Oswald Von Rosen seemed disposed to eat six or seven railway porters, which would have involved us in a serious claim for damages.

He demanded whether we could not be allowed to walk across the bridge and on to Omaha. Certainly not. He wanted to have some clear understanding as to how late this other train was likely to be. Nobody knew.

"*Du lieber Himmel!*" we heard him muttering to himself, somewhere about eleven o'clock, "and in this confounded country the very sky is black with telegraph lines, and they cannot tell you if we shall be here all the night! *Is it the beetles that have stopped the train?*" he suddenly demanded of a guard who was sitting on a handbarrow and playfully swinging a lamp.

"I guess not," was the calm answer.

"We might have been over the river and back half-a-dozen times — eh?"

"That's so," said the guard, swinging the lamp.

It was near midnight when the other train arrived, and then the station resounded with the welcome cry of "All aboard!" But we flatly declined to re-enter one of those hideous compartments full of foul smells and squalor. We crowded together on the little iron balcony

between the cars, clinging to the rails; and by-and-by we had a dim impression that we were in mid-air, over the waters of the Missouri, which we could not see. We could only make out the black bars of the iron bridge against the black sky, and that indistinctly. Still, we were glad to be moving; for by this time we were desperately hungry and tired; and the sumptuous hospitality of Omaha was just before us.

Alas! alas! the truth must be told. Omaha received us in the most cruel and hard-hearted fashion. First of all, we imagined we had blindly wandered into a kingdom of the bats. There were some lights in the station, it is true; but as soon as we had got into the hotel omnibus and left these gloomy rays it appeared as though we had plunged into outer darkness. We did not know then that the municipal authorities of the place, recognizing the fact that business had not been brilliant, and that taxes lay heavily on themselves and their neighbors, had resolved to do without gas in order to save expense. All we knew was that this old omnibus went plunging frantically through absolute blackness, and that in the most alarming manner. For what were these strange noises outside? At one moment we would go jerking down into a hollow, and the "swish" of water sounded as if we had plunged into a stream, while we clung to each other to prevent our being flung from one end to the other of the vehicle. And then, two seconds afterwards, it really did appear to us that the horses were trying to climb up the side of a house. There was one small lamp that threw its feeble ray both outward and inward; and we saw through a window a wild vision of a pair of spectral horses apparently in mid-air, while inside the omnibus the lieutenant was down at the door, vainly trying to keep his wife from tumbling on the top of him.

"It is my firm conviction," said Queen T., panting with her struggles, "that we are not going along a road at all. We are going up the bed of the Missouri."

Then there were one or two more violent wrenches, and the vehicle stopped. We scrambled out. We turned an awe-stricken glance in the direction we had come; nothing was visible. It was with a great thankfulness that the shipwrecked mariners made their way into the hotel.

But was it hospitable, was it fair, was it Christian of the Grand Central of Omaha to receive us as it did, after our manifold perils by land and water? Had we been saved from drowning only to perish of starvation? In the gloomy and echoing hall loud sounded the remonstrances of the irate lieutenant.

"What do you say?" he demanded of the highly indifferent clerk, who had just handed us our keys. "Nothing to eat? Nothing to drink? Nothing at all? And is this a hotel? *Hé!* It is nonsense what you say. Why do you let your servants go away, and have everything shut up? It is the business of a hotel to be open. Where is your kitchen — your larder — what do you call it?"

In reply the clerk merely folded up his book of names, and screwed out one of the few remaining lights. Happily there were ladies present, or a deed of blood would have dyed that dismal hall.

At this moment we heard the click of billiards.

"Ha!" said the lieutenant.

He darted off in that direction. We had seen something of billiard-saloons in America. We knew there were generally bars there. We knew that at the bars there were frequently bread and cheese supplied gratis. Behold! the foraging soldier returns! His face is triumphant. In his hands, under his arms, are bottles of stout; his pockets are filled with biscuits; he has a paper packet of cheese. Joyfully the procession moves to the floor above. With laughter and gladness the banquet is spread out before us; let the world wag on as it may, there is still, now and again, some brief moment of happiness. And we forgave the waiting at Council Bluffs, and we forgot the beetles, and we drank to the health of Omaha!

But it was too bad of you, Omaha, to receive us like that, all the same.

From The Queen.

GLAMOR.

WHAT is the spell which binds sweetness to peevishness, feminine delicacy to hybrid coarseness, unselfishness to domination, and self-denying love to rampant egotism? Who knows? There are mysteries in sea and sky which no man has yet fathomed; but greater than them all is the mystery of human love, and why one ungainly soul is prized, and another, beautiful and precious, is discarded!

What friendship is in its degree, so is marriage to a still more striking extent. We sometimes see the sweetest and dearest little woman in the world married to a bluff, burly, crossgained fellow, who goes through life like a perpetual thunder-cloud

from which the slightest shock brings angry splutterings, sullen murmurs, and fiery outbursts, destructive of all peace and comfort. Yet Titania worships her rough-skinned treasure; he is her "gentle joy" to her, and she finds her happiness in wreathing garlands for his long-eared head, and in idealizing him — dull ass as he is — till she has made him into a god by whom all men might take a pattern. Her sister, married to Hyperion, as good as he is beautiful, and as clever as he is good, finds her lot in life a hard one, and thinks every wife is to be envied where she is only to be pitied. She talks feelingly of the dreadful punishment which falls on women who make the one great mistake of their lives, and waxes eloquent on the sin of parents in suffering their daughters to marry before they know their own minds or those of the men whom they take for better and worse. Her eyes fill up with tears when she speaks of Titania's happiness, and how good and kind, for all his rough exterior, is that long-eared Bottom of hers who shows his rough side to the world but keeps only his down and velvet for home. And then she sighs, and looks out into the distance as one whose heart is full of sadness, and whose tongue might say bitter things if she would; but she will not. If unhappy, she is loyal; if unappreciated, and not fairly dealt by, she understands the holy reticence of martyrdom; and though her marriage has been a mistake, she will not make the world the confidant of her griefs. Nevertheless, she gives that same world clearly to understand that she is unhappy and has been taken in, and that man for man Hyperion does not come near to Bottom, and Titania is to be congratulated while she is only to be commiserated. This is glamor in an inverted form — glamor dealing with poison not ambrosia, but quite as general as the other, if somewhat more distressing.

It must not be thought that women alone have the fee-simple of this kind of thing; that they and they only love the base and despise the noble by the influence of that strange state of mind which, for want of a better word, we are forced to call glamor. Perhaps we see it even more distinctly in men, for the objects to which the stronger sex sometimes carry their worship, or it may be their displeasure, are certainly of a kind which make other women — behind the scenes — open their eyes and ask, Why? Look at that unsuspecting honest-hearted gentleman who gives his good old family name and personal honor into the keeping of a woman who has not one qualification to make her a worthy custodian of either; and very many which one might have thought would have made any wise man hesitate before he gave himself and his precious treasures into such perilous guardianship. He alone ignores what all other men know; he alone believes where others more than doubt. The woman, to eyes untouched by glamor, has not a charm; she is rude and violent, ill-bred and vulgar; her very beauty, what there is of it, is of a low type; and in all probability she has lost the freshness of her skin as long ago as that of her mind. Yet the man whom she holds in thrall loves her, and marries to his ruin a kind of nineteenth century Circe, who, if she does not transform him into a swine, does lower the tone of his mind, so that she makes him accept dishonor for fame and humiliation for glory. But his brother, who has found Solomon's "crown of glory," thinks no more of his treasure than if it were an old brown paper cap; and lets what might have been the sweetness of his married life run to waste through neglect and indifference — as one who gives up his stately flower-garden and noble orchard to thorns and briars, and lets his cask of Shiraz wine run into the sand for the want of a little care in hoops and nails to keep the wood together.

Love of itself is glamor, and the strongest to be found. No lessons learnt by experience, however sharply taught and sadly conned, can enlighten the numbed senses which love has sent to sleep by its magic fascination; and things as plain as the sun in heaven to others, are dark as night, unfathomable as the sea to those who let themselves love before they prove.

Glamor, the fascination of certain professions; glamor, the passionate absorption of art; glamor, that unreasoning love of place which makes you accept all sorts of personal discomfort and moral disquietude that you may look out on those woods, watch the coming and going of those waves, study the lights and shadows as they fall on those mountains, find the maidenhair in that cleft, and the bee-orchis in yonder bank! But what would life be without this glamor? A dull house of rough wood wherein the soul gloomed through its miserable days, and whereto no beauty came, no love, no poetry, no idealizing brightness of fancy, making the mean things great and the sordid noble. If a bad master, glamor, like much else, is a good servant; and while kept under manageable control is a faculty for which we may thank God for his gift, not bewail the lot of man for his possession.